

## 9.0 CONSTRUCTION EQUIPMENT AND METHODS

Paving mixtures containing asphalt emulsions have been successfully mixed and placed using a wide range of techniques and equipment in both the mixing and spreading operations. Several excellent references are available which contain details on construction methods and equipment which have successfully been used with emulsified asphalt mixtures (3, 6, 9). Brief discussions of the various construction methods follow.

### 9.1 Mixing and Spreading

Successful mixing and spreading of emulsified asphalt mixtures have been accomplished using diverse techniques ranging from in-place mixing with a motor grader blade to central plant mixing using a batch or drum plant.

Blade. Blade mixing is probably the least efficient of available mixing methods for emulsions mixtures (6). However, it is also the least complicated. Basically, the procedure consists of spray applying water and emulsion using a distributor truck to a flattened windrow of aggregate. Mixing is accomplished through blading the materials back and forth several times to distribute the emulsion through the aggregate. Spreading of the mixed material is accomplished by careful blading with the grader.

Travel Plants. A travel plant is a self-propelled pugmill which proportion and mix emulsions and aggregates in place as the plant moves along the road (6). Two types of plants which are classified on method of receiving aggregate are available. The first is a dump-feed type which receives aggregate from a dump truck. The second is a pick-up type which receives aggregate by picking it up from previously prepared windrows. With each plant type, emulsion is introduced into the mixing chamber using spray bars. Generally, pick-up type plants leave the mixture in a windrow after mixing. Thus, the mixture must be spread using a motor grader. Dump feed plants generally place the mixtures uniformly by use of a screed thus eliminating the necessity of blade spreading. The dump feed travel plant has been found to be a very effective, successful, and popular method of mixing and placing emulsified mixtures.

Rotary Mixers. Rotary mixers generally consist of a mobile mixing chamber which contains rotary shafts with cutting blades mounted on a self-propelled machine (6). The mixer loosens in place material to the required depth and then mixes it with emulsion. Emulsified application may be either through a spray bar in the mixer, or by a distributer truck ahead of the mixer.

Central Plant. Emulsified asphalt mixtures have been successfully mixed in standard pugmill batch plants and continuous drum-mix plants. Mixtures may be made using either cold (ambient temperature) mixing or hot (elevated temperature) mixing (6). These mixtures may be spread using conventional equipment and techniques used for hot-mixed asphalt concrete. With central plant cold mixed emulsified asphalt mixtures, stockpiling of the mixture for long periods of time, prior to use, as is often the case with cutback asphalt mixtures may not be possible. Length of time an emulsified asphalt mixture may be stockpiled prior to use depends on the type of emulsion and aggregate used.

#### 9.2 Compacting

Equipment and techniques used to compact emulsified asphalt mixtures depend on the method used for mixing and the type of mixture being placed. During compaction, it is necessary to consider and make appropriate compensation for the amount of water in the mixture.

Mixed-in-Place. Mixed-in-place emulsified asphalt mixtures generally use local aggregate materials which are of low to marginal quality. Compaction of these materials is generally accomplished by initially compacting (breakdown rolling) using a sheepfoot or pneumatic tired roller just before, or just as the emulsified asphalt binder begins to break. Attempting to intially compact too soon may result in mixture shoving by the roller due to presence of excessive moisture in the mixture which will decrease mixture stability. Rolling to meet density requirements may be accomplished using steel wheel, pneumatic, or vibratory rollers. Finish rolling should be performed with a steel wheel roller. Further details of compaction techniques and equipment may be found in References 3, 6, and 9.

Central Plant Mixed. For central plant mixed emulsified asphalt mixtures, rolling should generally be performed as soon as possible after lay down as in many cases due to the time required for hauling and placing of the mixture, the emulsion may have begun to break. However, initial rolling should not be performed until the mixture is stable enough to support the roller. Initial rolling is generally accomplished using pneumatic rollers, intermediate rolling with either pneumatic or steel wheel rollers, and finish rolling with steel wheel rollers. Further information on compaction of plant-mixed emulsified asphalt mixtures are also found in References 3, 6, and 9.

## 10.0 CONCLUSIONS

Based on testing, mixture designs, and analyses performed with the materials studied during this investigation, several conclusions regarding the use of solvent free asphalt and sulfur-extended asphalt emulsions with aggregates from California may be drawn.

### 10.1 Solvent Free Asphalt Emulsions

A summary of ANOVA significant at the 95 percent confidence level is tabulated in Table 33. This table shows for nearly all dependent variables, that emulsion type, aggregate quality level, and aggregate are significant effects. For several parameters, several interactions are also significant. Conclusions reached during the asphalt emulsion experiment are.

1. Stable, solvent free cationic slow set and cationic medium set asphalt emulsions can be produced which meet Caltrans specifications for cationic emulsions.
2. Solvent free cationic asphalt emulsions can effectively coat aggregates with minus No. 200 mesh contents in excess of 10 percent and sand equivalent values as low as 15. Greater degrees of coating are obtained with solvent free cationic slow set emulsions than with solvent free cationic medium set emulsions.
3. In the laboratory and for the materials used in this study, greater degrees of compaction can be obtained using a conventional cationic medium set emulsion which contains 7 percent solvent than with solvent free asphalt emulsions.
4. Higher stabilometer values, cohesiometer values, and resilient moduli are obtained for laboratory mixtures containing low quality aggregates with the solvent free asphalt emulsions than with the emulsion containing solvent. This is believed due to the higher viscosity of the solvent free emulsion residues when compared to the residue from the emulsion containing solvent.

Table 33

SUMMARY OF ANOVA SIGNIFICANCE AT  
THE 95 PERCENT CONFIDENCE LEVEL,  
ASPHALT EMULSION EXPERIMENT

**DEPENDENT VARIABLES**  
**EFFECTS**

	A	Q	E	AQ	AE	QE	AQE
Emulsion Compatability	Y	Y	Y	-	Y	-	-
Film Stripping	Y	N/A	-	N/A	-	N/A	N/A
2 Day Modulus	Y	Y	Y	-	Y	Y	Y
Full Cure Modulus	Y	Y	Y	-	-	-	-
Density	Y	Y	Y	-	-	-	-
Air Voids	Y	Y	Y	-	-	-	-
Stabilometer	Y	Y	Y	Y	Y	Y	-
Cohesiometer	Y	Y	Y	Y	Y	-	-
MVS Stabilometer	Y	Y	Y	-	Y	Y	-
MVS Cohesiometer	-	-	Y	-	-	-	-
Swell	Y	Y	Y	Y	Y	Y	Y
Surface Abrasion	Y	Y	Y	Y	Y	Y	Y

LEGEND:**Effects:**

A = effect of aggregate type  
 Q = effect of aggregate quality level  
 E = effect of emulsion type  
 AQ = aggregate-aggregate quality interaction  
 AE = aggregate-emulsion interaction  
 QE = aggregate quality-emulsion interaction  
 AQE = three-way interaction

**Significance:**

Y = significant at the 95% confidence level  
 - = not significant at the 95% confidence level  
 N/A = does not apply as analysis is a two-way

5. Laboratory specimens containing solvent free asphalt emulsions experience higher losses of stabilometer value after conditioning using the moisture vapor sensitivity procedure than specimens with the asphalt emulsion containing solvent. This effect, however, may be related to the lesser degrees of compaction attained when using the solvent free asphalt emulsions as compared to the emulsion containing solvent.
6. Laboratory specimens which contained the solvent free asphalt emulsions with lower quality aggregates experienced higher amounts of swell and greater surface abrasion losses than specimens with the emulsion containing solvent.
7. Due to the greater stiffness of mixtures containing the solvent free asphalt emulsions as compared to the solvent asphalt emulsion, lesser pavement thicknesses are required when using solvent free emulsions. It is noted that the pavement section design procedure used herein does not consider the moisture sensitivity of the materials which may be an important factor in field performance.
8. Most of the paving mixtures investigated which contained the low quality aggregates and the solvent free asphalt emulsions met stabilometer requirements for Caltrans Type C asphalt concrete. However, only three of the mixtures also met moisture vapor susceptibility and swell requirements. Mixtures which met these requirements were - FH with CSS-0 emulsion, GRH with CMS-0 emulsion, and GRH with CMS-7 emulsion.
9. The desirability of using solvent free aqueous emulsion asphalt concrete mixes for secondary road construction, in view of the positive and negative laboratory test results obtained for laboratory prepared and tested specimens, must remain a judgement of the highway construction engineer who must consider pollution abatement achievable through the use of emulsified asphalt systems and weigh this against other considerations as cost effectiveness and road durability among others.

## 10.2 Sulfur-Extended-Asphalt Emulsions

A summary of ANOVA significance at the 95 percent confidence level is shown in Table 34. This table shows for nearly all parameters, that emulsion type, aggregate quality level, and aggregate are significant effects. For several parameters, several interactions are also significant. Conclusions reached during the SEA emulsion experiment are.

1. Stable solvent free, water based, anionic slow set emulsions using sulfur-extended-asphalt (SEA) base stocks can be produced which meet most Caltrans specifications for anionic slow set emulsions.
2. Anionic SEA emulsion can effectively coat both low and high quality aggregates.
3. Use of SEA emulsions resulted in higher resilient modulus values for both low and high quality aggregates than use of the emulsion containing solvent.
4. Mixtures containing the SEA emulsions had higher stabilometer values with low quality aggregates than mixtures with the emulsion containing solvent.
5. Specimens containing the SEA emulsion with low quality aggregates swelled to a greater extent and experienced higher surface abrasion losses than those with the emulsion containing solvent.
6. Specimens containing the SEA emulsions experience greater losses of stabilometer value after conditioning using the moisture vapor sensitivity procedure than specimens with the solvent asphalt emulsion indicating a greater sensitivity to moisture.
7. Due to the greater stiffness of mixtures containing the SEA emulsions as compared to the solvent asphalt emulsion, lesser pavement thicknesses would be required when using SEA emulsions. Again, it is noted that the pavement section design procedure used herein does not consider the moisture sensitivity of the materials.

Table 34

**SUMMARY OF ANOVA SIGNIFICANCE AT  
THE 95 PERCENT CONFIDENCE LEVEL,  
SULFUR-EXTENDED-ASPHALT EMULSION EXPERIMENT**

**DEPENDENT VARIABLES  
EFFECTS**

	A	Q	E	AQ	AE	QE	AQE
Emulsion Compatability	Y	Y	Y	-	Y	-	-
Film Stripping	Y	N/A	Y	N/A	Y	N/A	N/A
2 Day Modulus	Y	Y	Y	-	Y	Y	Y
Full Cure Modulus	Y	-	Y	-	-	-	-
Density	Y	Y	Y	-	-	Y	Y
Air Voids	Y	Y	Y	-	-	-	-
Stabilometer	-	Y	Y	-	Y	-	-
Cohesiometer	-	Y	-	-	-	-	-
MVS Stabilometer	Y	Y	Y	Y	Y	-	-
MVS Cohesiometer	Y	Y	Y	-	Y	Y	-
Swell	Y	Y	Y	Y	Y	Y	Y
Surface Abrasion							

**LEGEND:****Effects:**

A = effect of aggregate type  
 Q = effect of aggregate quality level  
 E = effect of emulsion type  
 AQ = aggregate-aggregate quality interaction  
 AE = aggregate-emulsion interaction  
 QE = aggregate quality-emulsion interaction  
 AQE = three-way interaction

**Significance:**

Y = significant at the 95% confidence level  
 - = not significant at the 95% confidence level  
 N/A = does not apply as analysis is a two-way

8. All of the paving mixtures containing low quality aggregates and SEA emulsions studied met Caltrans stabilometer requirements (30 minimum) for Type C asphalt concrete, however, several mixtures did not meet swell and moisture vapor susceptibility requirements for Type C asphalt concrete. Mixtures containing the SEA emulsions which met swell requirements were FH, GRH, and GRL with SS-15 SEA emulsion, and SBH, FH, FL, GRH, and GRL with SS-30 SEA emulsion. MVS conditioned stabilometer value requirements were met only by FL and GRH with the SS-15 SEA emulsion and GRH with the SS-30 SEA emulsion.
9. The desirability of using solvent free aqueous emulsion asphalt concrete mixes for secondary road construction, in view of the positive and negative laboratory test results obtained for laboratory prepared and tested specimens, must remain a judgement of the highway construction engineer who must consider pollution abatement achievable through the use of emulsified asphalt systems and weigh this against other considerations as cost effectiveness and road durability among others.

## 11.0 RECOMMENDATIONS

- 11.1 This study has investigated the properties of paving mixtures containing several low quality aggregates and several types of emulsified binders. Test methods and criteria used to design and assess mixture characteristics were those specified for hot-mix asphalt concrete in California. An objective of the research study is to determine if solvent free emulsified binders can be used in place of cutback asphalt binders. Therefore, in order to permit drawing of appropriate conclusions from the data presented in this report on the effectiveness of the emulsions studied for replacing cutback asphalts, additional laboratory work is required. It is suggested that properties and characteristics of mixtures containing the project aggregates and cutback asphalts be determined. The study should evaluate the same properties considered in this study. Determination of mixture characteristics using cutback binders would permit direct comparisons between the cutback and emulsified binder systems and the drawing of more definite conclusions. Additionally, a study which would determine properties of mixtures containing hot-mixed asphalt cement would be of aid in evaluating results.
- 11.2 After completion of the additional laboratory studies, if results so indicate, it is recommended that several field experimental studies using aggregates ranging in quality from low to high with solvent free emulsified asphalt binders be undertaken. Projects should be constructed in several climatic regions in California (wet and arid) and should include control sections containing both cutback and, if possible, hot-mixed asphalts. Proper laboratory mixture designs, construction control, and field monitoring of results and performance should be used. Results of these experiments should provide indications of performance of the various mixtures in actual use.
- 11.3 Results of this study indicate that mixtures containing the SEA binders are detrimentally affected by moisture to a greater degree than with standard emulsions. However, performance of mixtures containing the SEA emulsions may be adequate in arid regions. Therefore, it is recommended that in order

to further investigate the usefulness of paving mixtures containing the SEA emulsions, that field experimental test sections using the SEA emulsions be constructed and evaluated.

- 11.4 It is strongly suspected that the moisture vapor susceptibility of the solvent free asphalt emulsion mixes evaluated herein could be reduced by a slight modification of the emulsion formulations. This possibility should be evaluated.

## References

1. Request For Proposals, "Investigation Into The Nature Of Emulsified Asphalts Compatible With California Local Aggregates And Substitution Of Sulfur For Asphalt In Aqueous Emulsified Systems," California Air Resource Board, Research Division, Sacramento, California, March, 1980.
2. American Society for Testing and Materials, 1981. Annual Book of Standards, Part 15, Road, Paving, Bituminous Materials; Travelled Surface Characteristics, Philadelphia, PA, 1981.
3. "Interim Guide to Full-Depth Asphalt Paving Using Various Asphalt Mixes," The Asphalt Institute, Pacific Coast Division, PCD-1, January, 1976.
4. Kennepahl, G.J.A., Logan, A., and Bean, D. C., "'Conventional' Paving Mixes with Sulfur-Asphalt Binders," Proceedings AAPT, Volume 44, 1975.
5. Deme, Imants, "Processing of Sand-Asphalt-Sulfur Mixes," Proceedings AAPT, Volume 43, 1974.
6. A Basic Asphalt Emulsion Manual, The Asphalt Institute, Manual Series No. 19 (MS-19), March, 1979.
7. "Control of Volatile Organic Compounds from Use of Cutback Asphalt," U.S. Environmental Protection Agency, Office of Air and Waste Management, Office of Air Quality Planning and Standards, Research Triangle Park, North Carolina, October 17, 1977.
8. Highway Chemicals Newsletter, Armak Highway Chemicals Department, Armak Company, McCook, Illinois, Fall, 1981.
9. Bitumils Mix Manual, Chevron, U.S.A., Asphalt Division, January, 1977.
10. Asphalt Pavement Engineering, Wallace, Hugh A., and Martin, J. Rogers, McGraw Hill Book Company, New York, 1967.
11. Spahr, J. D., "The Use of Emulsified Asphalt in Construction and Maintenance," Proceedings AAPT Volume 44, 1975.

12. Encyclopedia of Chemical Processing and Design, Asphalt Emulsions, Volume 4, 1977.
13. Dybalski, J. N., "The Chemistry of Asphalt Emulsions," Presented at the Fifty-Fifth Annual Meeting of the Transportation Research Board, Washington, D. C., January, 1976.
14. Beagle, C. W., "Deflection and Performance of Deep Lift Asphalt Emulsion Base," Proceedings AAPT, Volume 45, 1976.
15. Meier, W. J., "Asphalt Emulsion Construction on the Navajo Reservation," Twenty-Fifth Annual Arizona Conference on Roads and Streets, University of Arizona, April 22-23, 1976.
16. Kallas, B. F., and Shock, J. F., "San Diego County Experimental Base Project Find Report - Parts I and II," Research Report 77-1, The Asphalt Institute, November, 1977.
17. Shook, J. F., "San Diego County Experimental Base Project: Analysis of Performance," Proceedings AAPT, Volume 45, 1976.
18. Wimberly, C. M. "Emulsified Asphalt Mixes in Arizona," Proceedings 24th Annual Arizona Conference on Roads and Streets, University of Arizona, April 17-18, 1975.
19. Izalt, J. O., Galloway, B. M., and Saylock, D., "Sand-Asphalt-Sulfur Pavement Experimental Project Highway U.S. 77, Kennedy County, Texas," Texas Transportation Institute, April, 1977.
20. McBee, W. C., and Sullivan, T. A., "Direct Substitution of Sulfur for Asphalt In Paving Materials," Report of Investigations 8303, U.S. Department of the Interior, Bureau of Mines, 1978.
21. Ludwig, A. C., Gerhardt, B. B., and Dale, J. M., "Materials and Techniques for Improving the Engineering Properties of Sulfur," Report No. FHWA-RD-80-023, Federal Highway Administration, June, 1980.
22. Jiminez, R. A., and Stakes, K. J., "Effects of Heat and Air on the Viscosity of Sulfur-Asphalt Mixtures," Presented at the 1981 Annual Meeting of Association of Asphalt Paving Technologies, San Diego, California, February 16-18, 1981.

23. Chehovits, J. G. and Anderson, D. A., "Upgrading of Marginal Aggregates for Improved Water Resistance of Asphalt Concrete," Transportation Research Record 762, pages 46-52, 1981.
24. Rosner, J. C. and Chehovits, J. G., "Highway Binder Materials From Modified Sulfur-Water Emulsions," Report No. FHWA/RD-82/035, Federal Highway Administration, November, 1981.
25. Standard Specifications, State of California Department of Transportation, January, 1978.
26. Applied Linear Statistical Models, Neter, J. and Wasserman, W., Richard D. Irwin, Inc., Homewood, Illinois, 1974.
27. Burr, I. W. and Foster, L. A., "A Test For Equality of Variances," Mimeograph Series No. 282, Statistics Department, Purdue University, Lafayette, Indiana, 1972.
28. Applied Statistical Methods, Burr, I. W., Academic Press, Inc., New York, 1974.
29. Parr, W. K., "Field Observations of the Behavior of Bituminous Pavements As Influenced By Moisture," ASTM Special Technical Publication No. 240, pages 3-16, 1959.
30. Rice, J. M., "Relationship of Aggregate Characteristics to the Effect of Water on Bituminous Paving Mixtures," ASTM Special Technical Publication No. 240, pages 17-34, 1959.
31. Lottman, R. P. and Johnson, D. L., "Pressure Induced Stripping in Asphaltic Concrete," Highway Research Record 340, pages 13-28, 1970.
32. Waller, F. H., Jr., "Emulsion Mix Design Methods: An Overview," Transportation Research Record 754, 1980.
33. "Design of Dense-Graded Emulsified Asphalt Mixtures," Report R6-350(74), U.S. Forest Service, 1974.
34. "Mix Design Procedure For Dense-Graded Emulsified Asphalt Pavement," FHWA Region 10, Office of Federal Highway Projects.

35. Darter, M. I., Ahlfield, S. R., Wilky, P. L., and Wasill, R. G., "Development of Emulsified Asphalt Aggregate Cold Mix Design Procedure," Research Report 505-5, Department of Civil Engineering, University of Illinois, 1978.
36. A. A. Gadallah, L. E. Wood, and E. J. Yoder, "A Suggested Method for the Preparation and Testing of Asphalt-Emulsion-Treated Mixtures Using Marshall Equipment," Proceedings AAPT, Volume 46, 1977.
37. "Marshall Stability," Highway Chemicals Department, Armak Company, McCook, Illinois.
38. Jiminez, R. A., "Final Report-Phase I, Asphalt Emulsion Treated Aggregates," University of Arizona, Research Report HPR-1-13(150), January, 1977.
39. George, K. P., "Interim Report on Criteria for Emulsified Asphalt Stabilization of Sandy Soils," University of Mississippi for Mississippi State Highway Department, October, 1976.
40. Fong, G. K., "Mix Design Methods for Base and Surface Courses Using Emulsified Asphalt A State-of-the-Art Report," Report No. FHWA-RD-78-113, Federal Highway Administration, October, 1978.
41. Schmidt, R. J., "A Practical Method for Measuring the Resilient Modulus of Asphalt-Treated Mixes," Highway Research Record 404, 1972.
42. "Manual of Test, Volume 2," State of California, Department of Transportation, Transporation Laboratory, Third Edition, 1978.
43. Mix Design Methods for Asphalt Concrete, Manual Series No. 2 (MS-2), The Asphalt Institute, March, 1979.



**APPENDIX A**

**OPTIMUM FLUIDS AT COMPACTION DATA**

Table Al. Fluids at Compaction Data,  
CSS-0

<u>Aggregate</u>	<u>Percent Residue</u>	<u>Moisture at Compaction, %</u>	<u>Percent Total Fluids</u>	<u>Dry Density (pcf)</u>
SBH	6.31	4.67	10.98	130.4
	6.31	3.67	9.98	133.7
	6.31	2.16	8.47	134.7
SBL	7.02	5.71	12.73	128.3
	7.02	4.13	11.15	132.6
	7.02	3.60	10.62	130.6
FH	5.95	4.55	10.50	133.1
	5.95	3.70	9.65	131.9
	5.95	3.41	9.36	131.7
FL	6.78	5.90	12.68	132.8
	6.78	4.50	11.28	129.5
	6.78	4.00	10.78	130.4
GRH	6.89	4.92	11.81	140.4
	6.89	1.83	8.72	152.9
	6.89	1.09	7.98	154.1
GRL	6.45	4.04	10.49	142.9
	6.45	3.11	9.56	146.6
	6.45	1.39	7.84	146.2

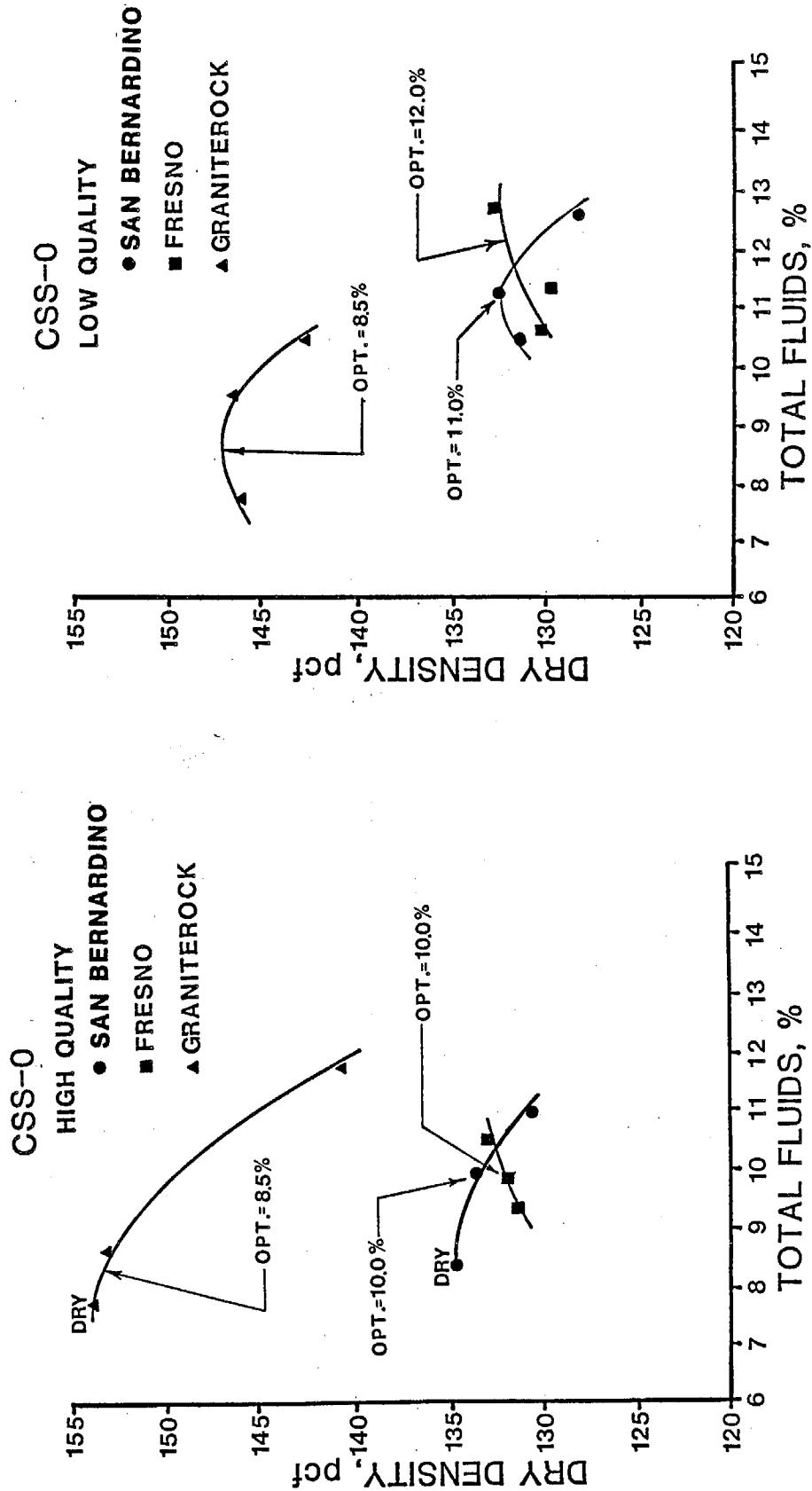


Figure A1. Fluids at Compaction, High Quality Aggregate, CSS-0

Figure A2. Fluids at Compaction, Low Quality, CSS-0

Table A2. Fluids at Compaction Data,  
CMS-0

<u>Aggregate</u>	<u>Percent Residue</u>	<u>Moisture at Compaction, %</u>	<u>Percent Total Fluids</u>	<u>Dry Density (pcf)</u>
SBH	6.05	4.16	10.21	133.1
	6.05	3.16	9.21	131.6
	6.05	1.83	7.88	131.6
SBL	7.04	4.94	11.98	130.5
	7.04	3.89	10.93	132.0
	7.04	2.62	9.66	131.3
FH	5.95	5.29	11.24	128.2
	5.95	3.92	9.87	131.3
	5.95	3.60	9.55	131.2
FL	6.95	5.19	12.14	132.1
	6.95	4.79	11.74	129.8
	6.95	3.01	9.96	127.9
GRH	5.56	2.84	8.40	147.8
	5.56	1.87	7.43	147.9
	5.56	1.24	6.80	146.3
GRL	6.04	3.19	9.23	145.2
	6.04	2.56	8.60	146.3
	6.04	1.65	7.69	145.3

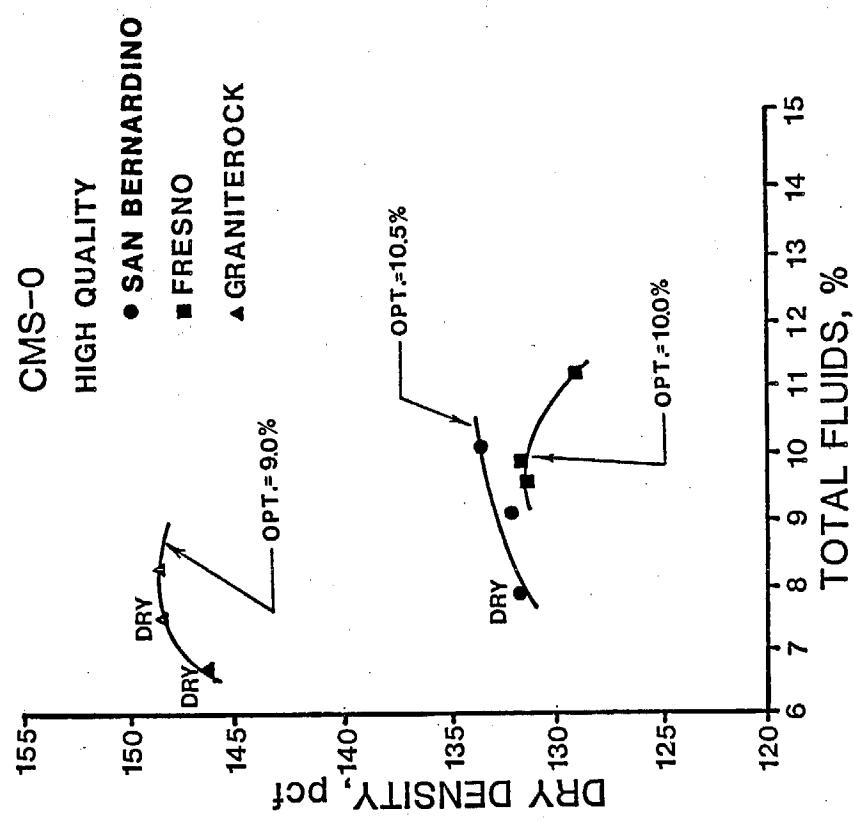


Figure A3. Fluids at Compaction,  
High Quality, CMS-0

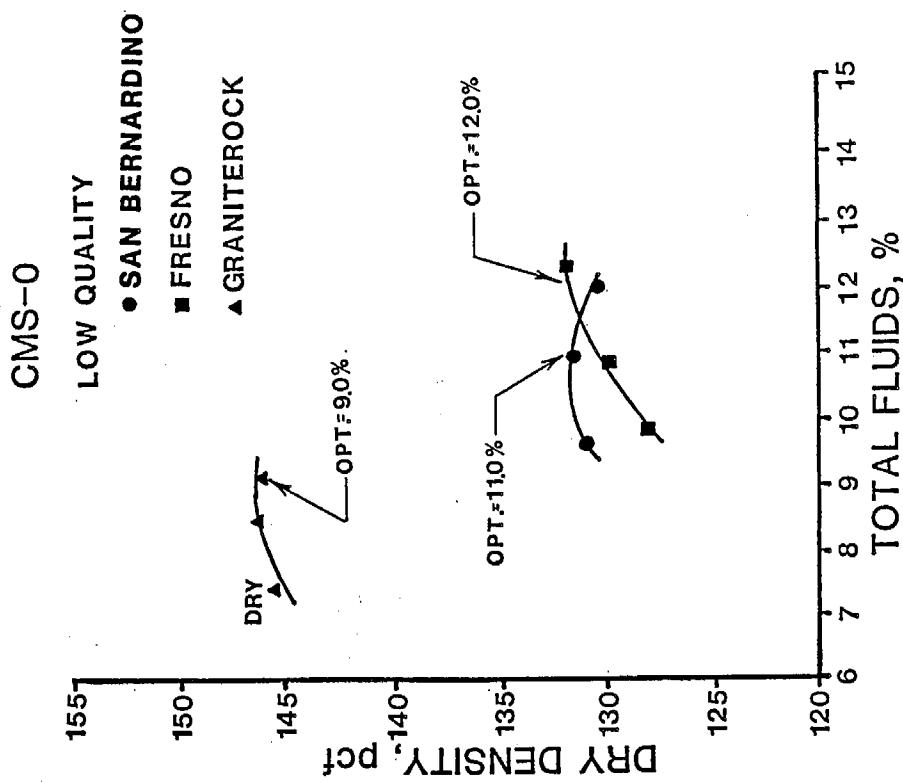


Figure A4. Fluids at Compaction,  
Low Quality, CMS-0

Table A3. Fluids at Compaction Data,  
CMS-7

<u>Aggregate</u>	<u>Percent Residue</u>	<u>Moisture at Compaction, %</u>	<u>Percent Total Fluids</u>	<u>Dry Density (pcf)</u>
SBH	7.69	4.60	12.29	132.9
	7.69	3.91	11.60	137.7
	7.69	2.94	10.63	137.6
SBL	7.46	5.73	13.19	133.5
	7.46	4.36	11.82	135.1
	7.46	3.01	10.47	134.2
FH	5.95	5.13	11.08	135.7
	5.95	3.80	9.75	133.3
	5.95	2.57	8.52	134.2
FL	7.14	5.13	12.27	129.9
	7.14	4.04	11.18	131.7
	7.14	3.34	10.48	130.8
GRH	5.70	2.31	8.01	151.9
	5.70	1.70	7.40	152.3
	5.70	0.80	6.50	149.8
GRL	5.87	2.63	8.50	150.3
	5.87	1.46	7.33	151.7
	5.87	1.09	6.96	151.4

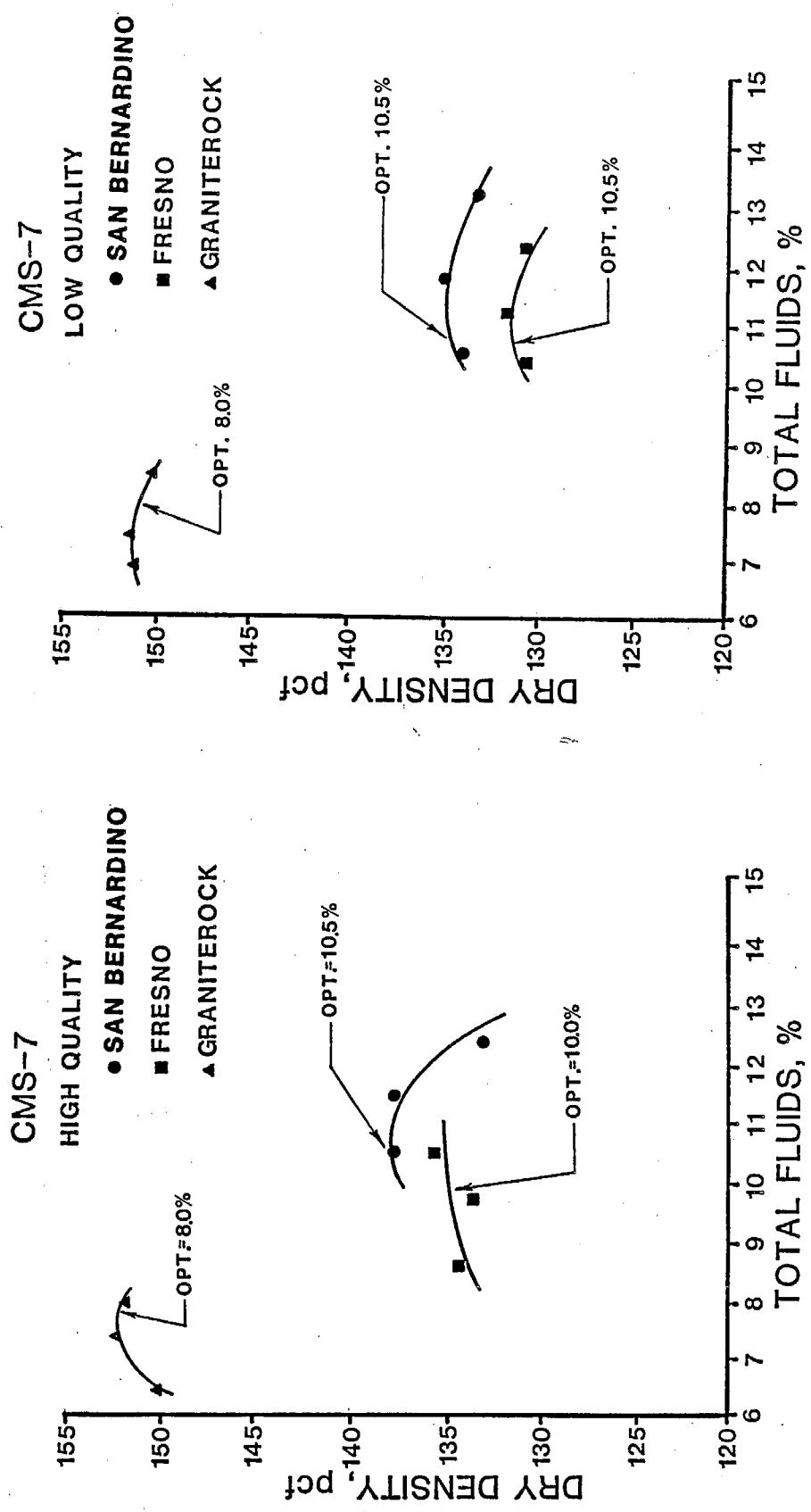
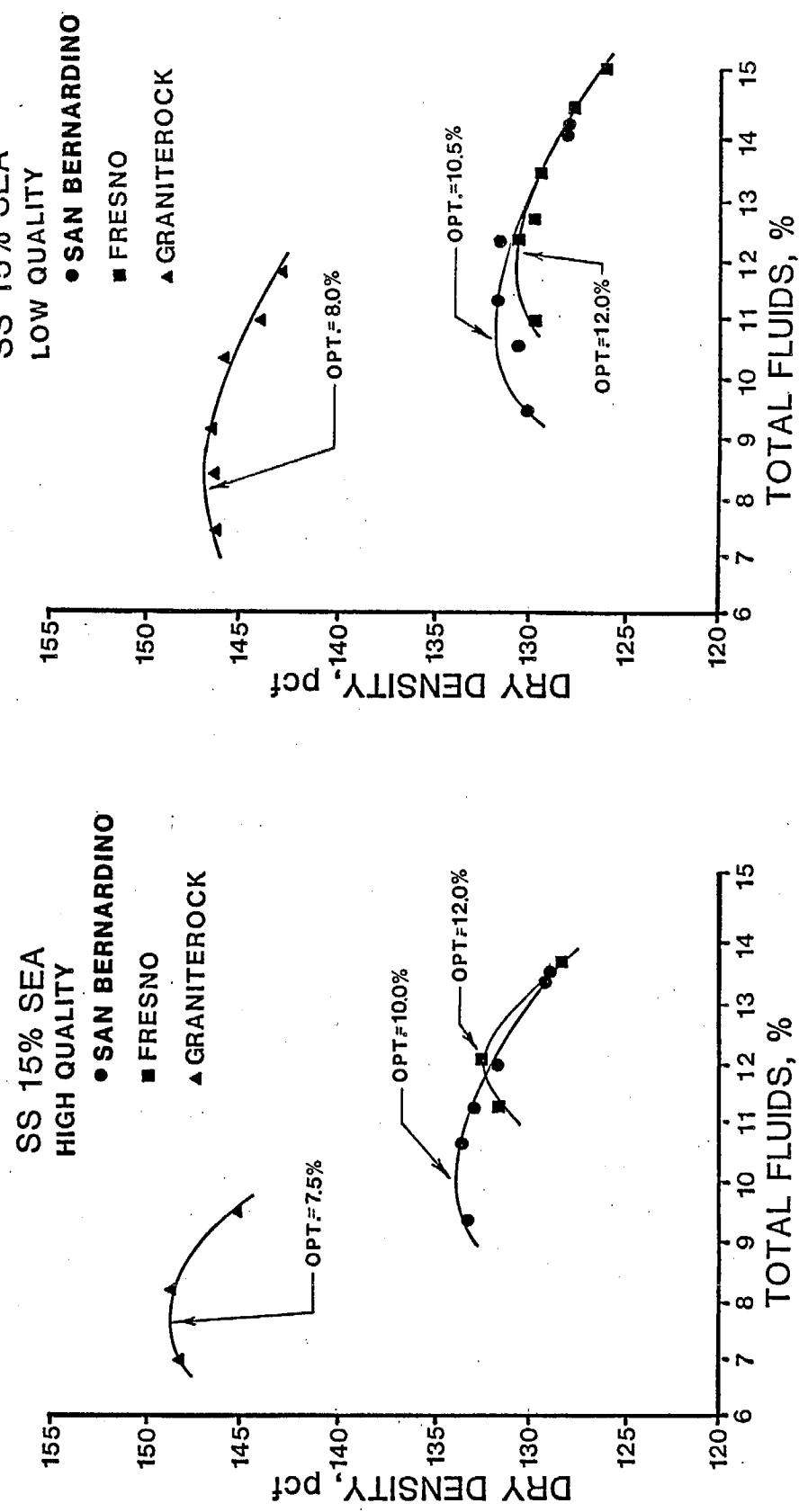


Figure A5. Fluids at Compaction,  
High Quality, CMS-7

Figure A6. Fluids at Compaction,  
Low Quality, CMS-7

Table A4. Fluids at Compaction Data,  
SS 15% SEA

<u>Aggregate</u>	<u>Percent Residue</u>	<u>Moisture at Compaction, %</u>	<u>Percent Total Fluids</u>	<u>Dry Density (pcf)</u>
SBH	7.65	5.63	13.28	128.9
	7.65	4.26	11.91	131.9
	7.65	3.15	10.80	133.5
	7.65	5.80	13.45	128.6
	7.65	3.46	11.11	133.1
	7.65	1.78	9.43	133.2
SBL	8.15	5.95	14.10	127.8
	8.15	4.18	12.33	131.4
	8.15	3.09	11.24	131.5
	8.15	5.99	14.14	127.6
	8.15	2.56	10.71	130.4
	8.15	1.37	9.52	129.9
FH	7.65	6.00	13.65	128.1
	7.65	4.40	12.05	132.5
	7.65	3.56	11.21	131.3
FL	8.17	6.83	15.00	125.9
	8.17	5.41	13.58	129.0
	8.17	4.18	12.35	130.3
	8.17	6.29	14.46	127.5
	8.17	4.57	12.74	129.2
	8.17	2.83	11.00	129.4
GRH	5.74	3.74	9.48	145.0
	5.74	2.47	8.21	148.5
	5.74	1.28	7.02	148.2
GRL	7.38	4.51	11.89	142.8
	7.38	3.01	10.39	145.9
	7.38	1.75	9.13	146.8
	7.38	4.35	11.73	143.7
	7.38	1.86	9.24	146.5
	7.38	0.73	8.11	146.5



A8

Figure A7. Fluids at Compaction,  
High Quality, SS 15% SEA

Figure A8. Fluids at Compaction,  
Low Quality, SS 15% SEA

Table A5. Fluids at Compaction Data,  
SS 30% SEA

<u>Aggregate</u>	<u>Percent Residue</u>	<u>Moisture at Compaction, %</u>	<u>Percent Total Fluids</u>	<u>Dry Density (pcf)</u>
SBH	6.88	5.95	12.83	129.9
	6.88	4.68	11.56	133.7
	6.88	1.50	8.38	133.2
SBL	7.22	6.45	13.67	128.6
	7.22	4.38	11.60	131.9
	7.22	2.67	9.89	132.4
	7.22	6.60	13.82	128.1
	7.22	5.66	12.88	130.2
	7.22	4.40	11.62	132.6
FH	6.80	6.50	13.30	129.1
	6.80	5.31	12.11	131.5
	6.80	4.32	11.12	133.3
	6.80	6.29	13.09	129.4
	6.80	4.22	11.02	133.3
	6.80	3.32	10.12	131.5
FL	7.26	7.67	14.93	125.9
	7.26	6.14	13.40	127.8
	7.26	4.43	11.69	132.2
	7.26	5.47	12.73	129.4
	7.26	3.70	10.96	131.3
GRH	5.10	4.13	9.23	146.4
	5.10	3.00	8.10	150.9
	5.10	1.67	6.77	149.6
GRL	5.96	4.68	10.64	143.5
	5.96	3.46	9.42	147.2
	5.96	1.91	7.87	149.9
	5.96	4.85	10.81	142.6
	5.96	2.58	8.54	148.7
	5.96	0.96	6.92	147.6

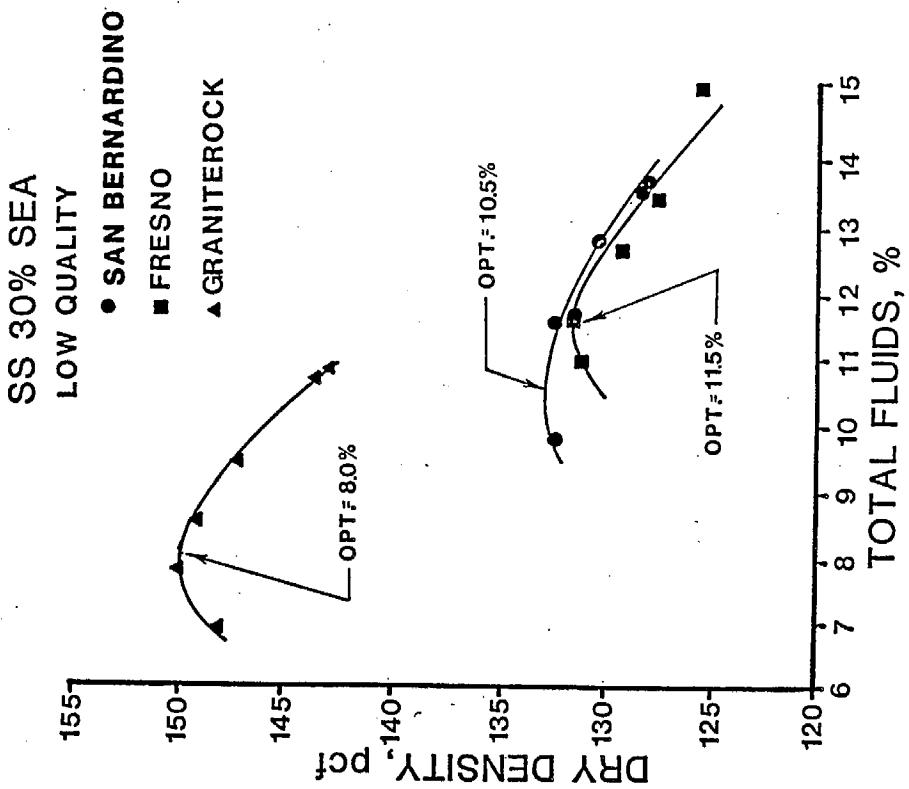
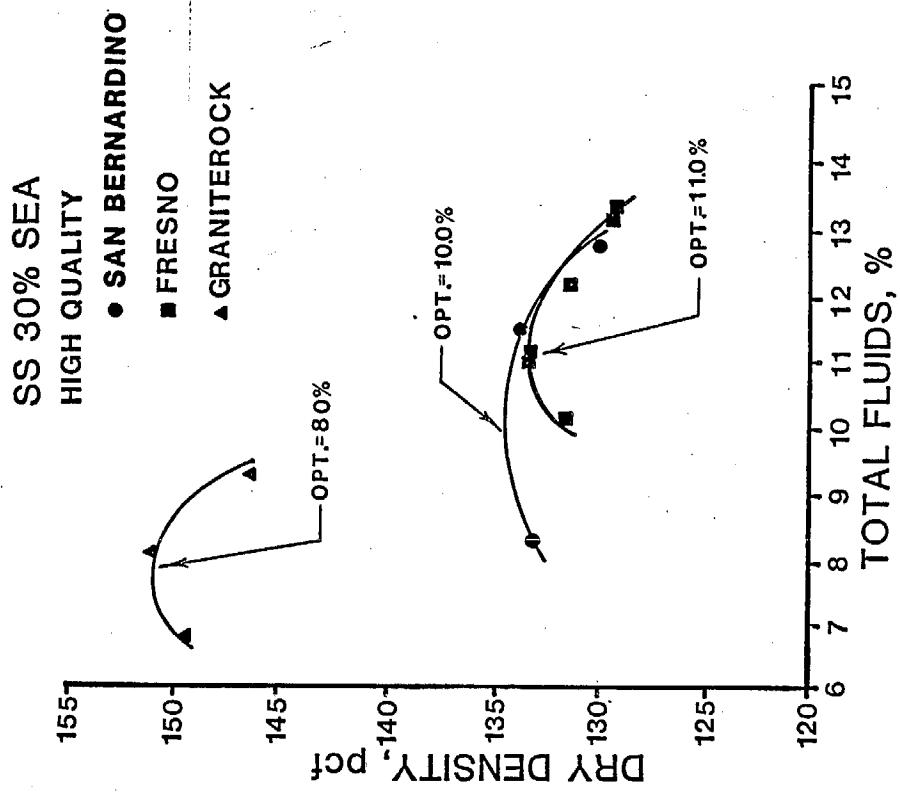


Figure A9. Fluids at Compaction,  
High Quality, SS 30% SEA

Figure A10. Fluids at Compaction,  
Low Quality, SS 30% SEA

**APPENDIX B**  
**MIXTURE DESIGN DATA**

TABLE B1. Mixture Design Data, San Bernardino,  
High Quality, CSS-0, Replication 1

Residue Content, %	5.0	6.0	7.0	Design 7.0 %
Bulk Specific Gravity	2.1740	2.1823	2.1772	---
Theoretical Specific Gravity	2.4488	2.4163	2.3853	---
Air Voids, %	11.2	9.7	8.7	8.7
V.M.A., %	19.4	19.9	20.8	20.8
Absorbed Asphalt, %	1.00	1.00	1.00	1.00
Effective Asphalt, %	4.00	5.00	6.00	6.00
Unit Weight,pcf	135.7	136.2	135.9	135.9
Stabilometer Value	37.5	33.0	27.2	27.2
Cohesiometer Value	197	207	193	193
Resilient Modulus, $10^3$ psi				
2-day	117	134	118	118
Final	345	271	260	260

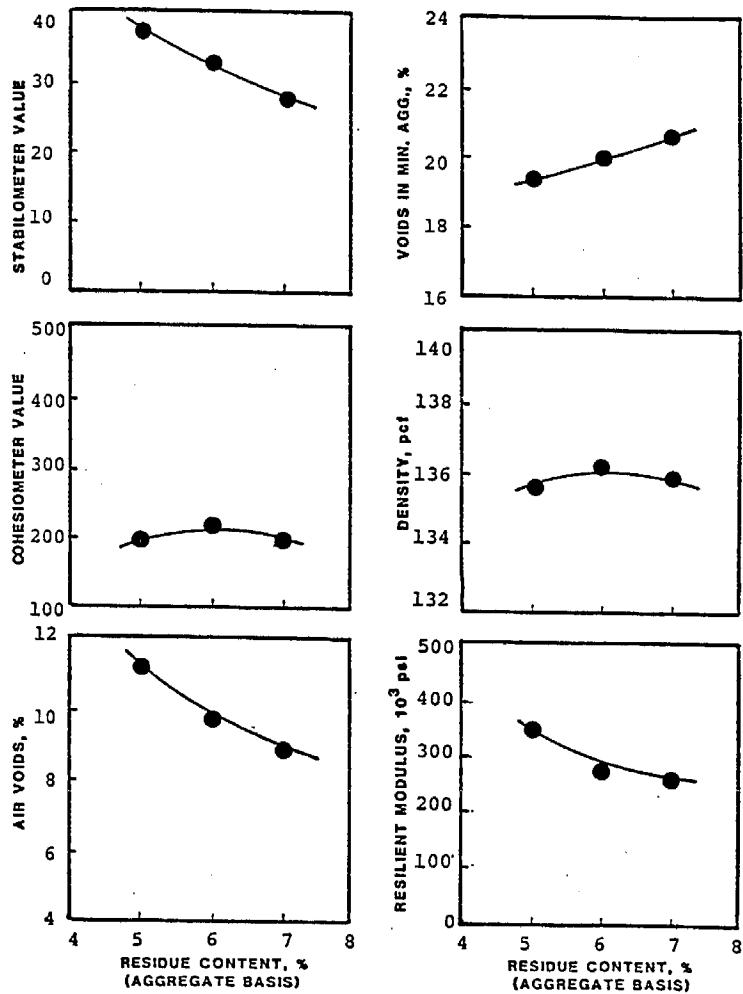


FIGURE B1. Mixture Design Data, San Bernardino,  
High Quality, CSS-0, Replication 1

TABLE B2. Mixture Design Data, San Bernardino,  
High Quality, CSS-0, Replication 2

Residue Content, %	5.0	6.0	7.0	Design 7.0%
Bulk Specific Gravity	2.1804	2.1863	2.1992	---
Theoretical Specific Gravity	2.4280	2.3964	2.3660	---
Air Voids, %	10.2	8.8	7.1	7.1
V.M.A., %	19.2	19.7	20.0	20.0
Absorbed Asphalt, %	0.63	0.63	0.63	0.63
Effective Asphalt, %	4.37	5.37	6.37	6.37
Unit Weight, pcf	136.1	136.4	137.2	137.2
Stabilometer Value	42.7	36.3	31.3	31.3
Cohesimeter Value	352	292	234	234
Resilient Modulus, $10^3$ psi				
2-day	85	63	83	83
Final	355	429	232	232

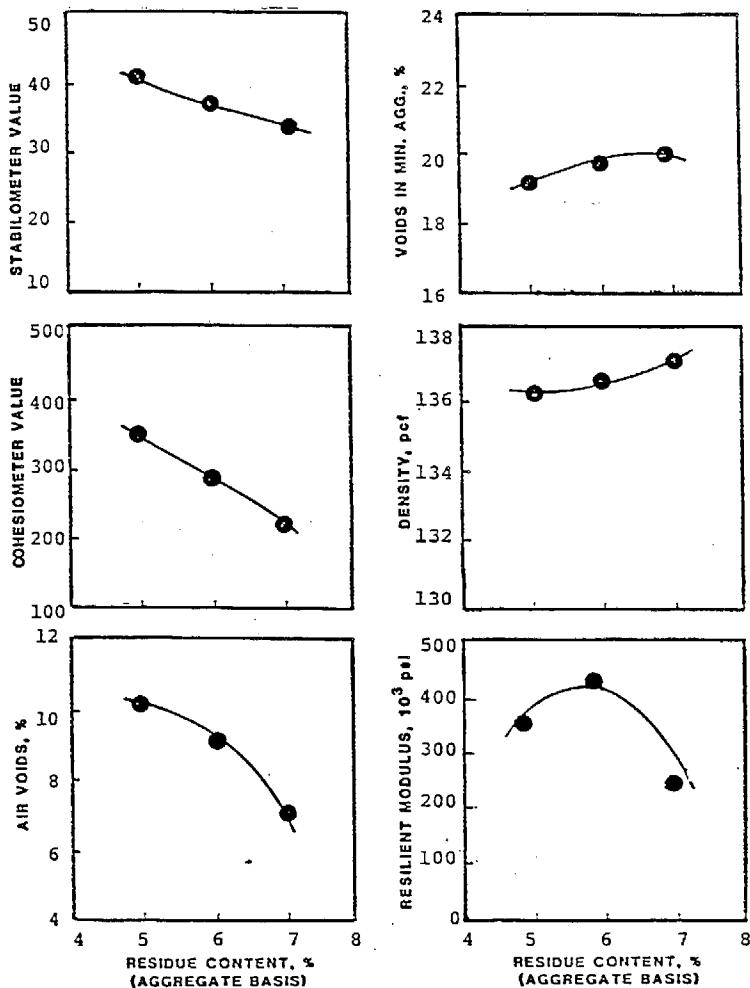


FIGURE B2. Mixture Design Data, San Bernardino,  
High Quality, CSS-0, Replication 2

TABLE B3. Mixture Design Data, San Bernardino,  
High Quality, CMS-0, Replication 1

Residue Content, %	5.0	6.0	7.0	Design 7.0 %
Bulk Specific Gravity	2.1308	2.1729	2.1595	---
Theoretical Specific Gravity	2.4562	2.4235	2.3922	---
Air Voids, %	13.2	10.3	9.7	9.7
V.M.A., %	21.0	20.2	21.5	21.5
Absorbed Asphalt, %	1.13	1.13	1.13	1.13
Effective Asphalt, %	3.87	4.87	5.87	5.87
Unit Weight, pcf	132.9	135.6	134.8	134.8
Stabilometer Value	37.8	34.5	37.5	37.5
Cohesimeter Value	314	270	280	280
Resilient Modulus, $10^3$ psi				
2-day	82	96	104	104
Final	281	260	267	267

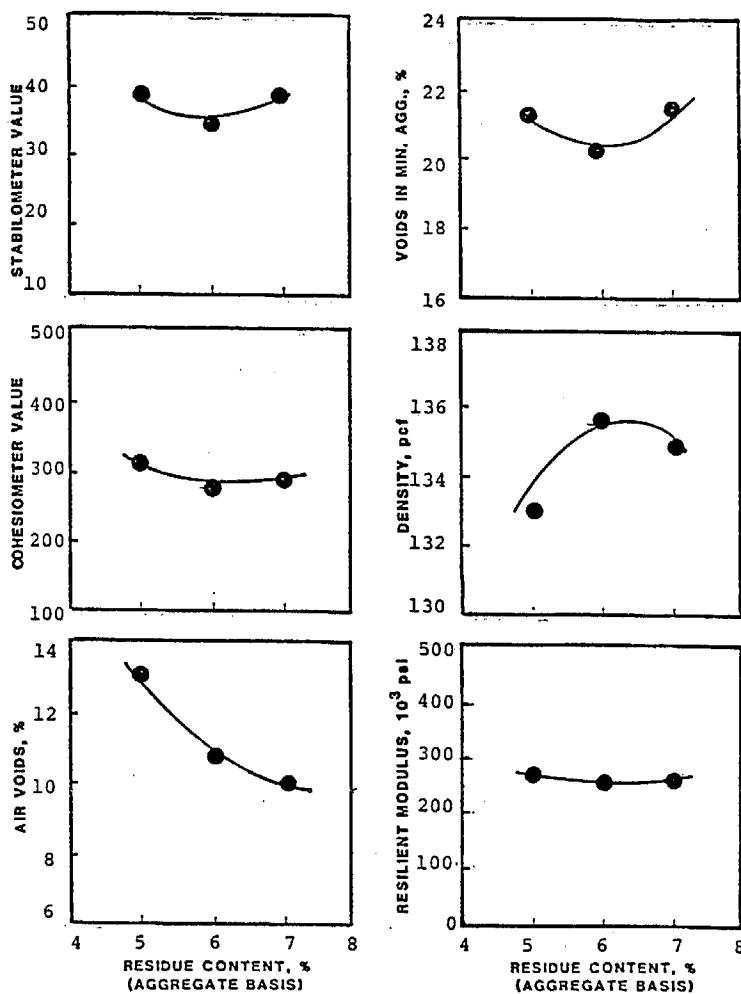


FIGURE B3. Mixture Design Data, San Bernardino,  
High Quality, CMS-0, Replication 1

TABLE B4. Mixture Design Data, San Bernardino,  
High Quality, CMS-0, Replication 2

Residue Content, %	5.0	6.0	7.0	Design 7.0%
Bulk Specific Gravity	2.1491	2.1459	2.1526	---
Theoretical Specific Gravity	2.4334	2.4014	2.3709	---
Air Voids, %	11.7	10.6	9.0	9.0
V.M.A., %	20.4	21.2	21.7	21.7
Absorbed Asphalt, %	0.72	0.72	0.72	0.72
Effective Asphalt, %	4.28	5.28	6.28	6.28
Unit Weight, pcf	134.1	133.9	134.3	134.3
Stabilometer Value	43.7	40.6	34.4	34.4
Cohesimeter Value	337	248	252	252
Resilient Modulus, $10^3$ psi				
2-day	61	66	82	82
Final	410	318	250	250

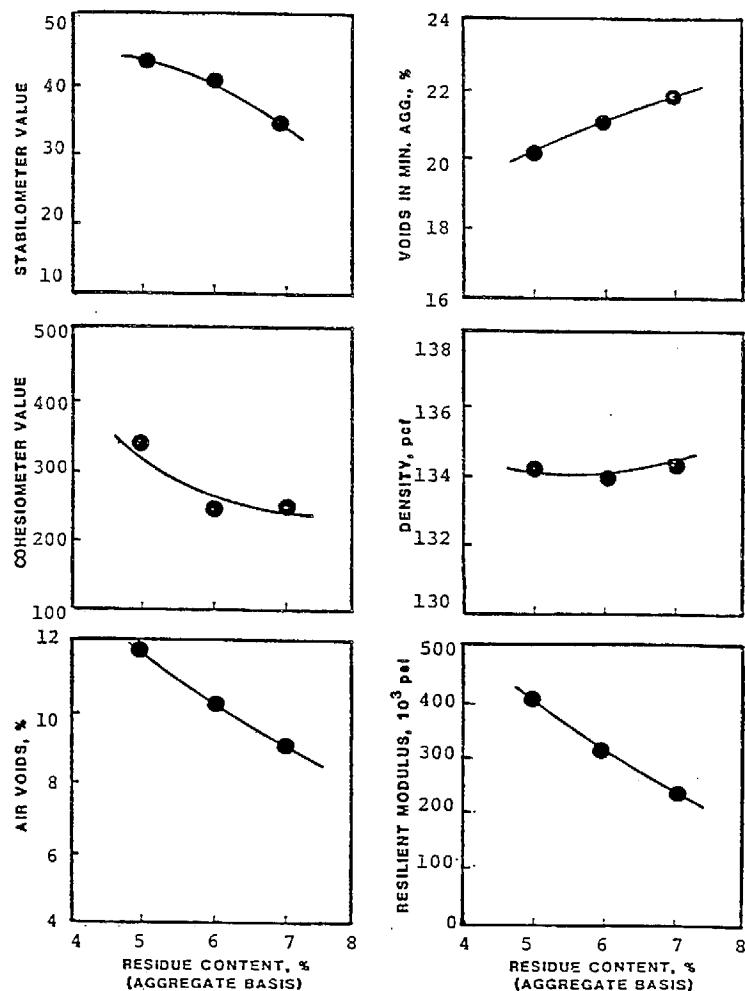


FIGURE B4. Mixture Design Data, San Bernardino,  
High Quality, CMS-0, Replication 2

TABLE B5. Mixture Design Data, San Bernardino,  
High Quality, CMS-7 Replication 1

Residue Content, %	5.0	6.0	7.0	Design 7.0%
Bulk Specific Gravity	2.1652	2.1904	2.2005	---
Theoretical Specific Gravity	2.4484	2.4149	2.3828	---
Air Voids, %	11.6	9.3	7.7	7.7
V.M.A., %	19.8	19.6	20.0	20.0
Absorbed Asphalt, %	1.07	1.07	1.07	1.07
Effective Asphalt, %	3.93	4.93	5.93	5.93
Unit Weight, pcf	135.1	136.7	137.3	137.3
Stabilometer Value	34.5	28.8	23.5	23.5
Cohesimeter Value	224	136	80	80
Resilient Modulus, $10^3$ psi				
2-day	18	17	21	21
Final	240	128	78	78

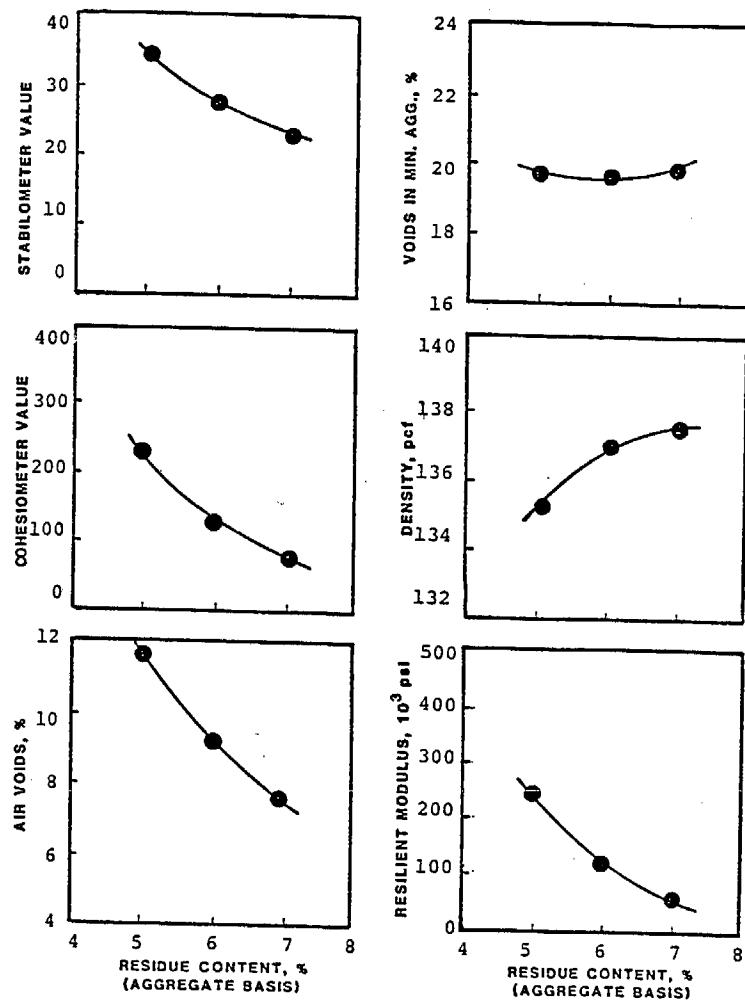


FIGURE B5. Mixture Design Data, San Bernardino,  
High Quality, CMS-7 Replication 1

TABLE B6. Mixture Design Data, San Bernardino,  
High Quality, CMS-7, Replication 2

Residue Content, %	5.0	6.0	7.0	Design 7.0 %
Bulk Specific Gravity	2.1679	2.1990	2.2190	---
Theoretical Specific Gravity	2.4595	2.4255	2.3931	---
Air Voids, %	11.9	9.3	7.3	7.3
V.M.A., %	19.7	19.3	19.3	19.3
Absorbed Asphalt, %	1.26	1.26	1.26	1.26
Effective Asphalt, %	3.74	4.74	5.74	5.74
Unit Weight, pcf	135.3	137.2	138.5	138.5
Stabilometer Value	35.7	28.3	23.5	23.5
Cohesimeter Value	126	103	82	82
Resilient Modulus, $10^3$ psi				
2-day	45	36	31	31
Final	203	132	64	64

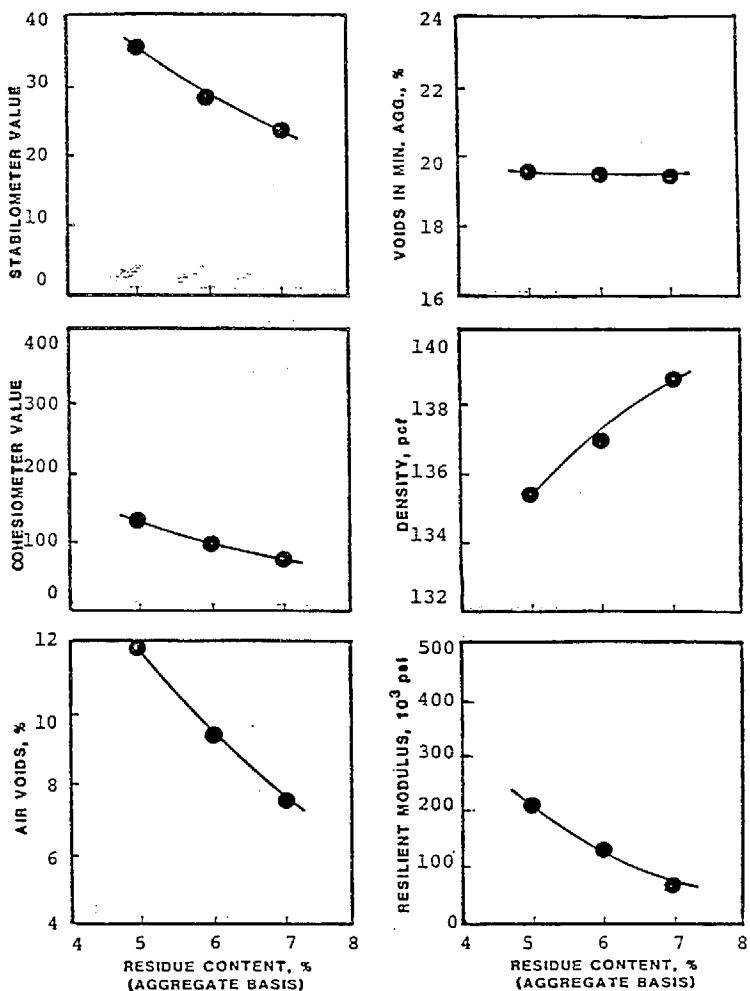


FIGURE B6. Mixture Design Data, San Bernardino,  
High Quality, CMS-7, Replication 2

TABLE B7. Mixture Design Data, San Bernardino,  
Low Quality, CSS-0, Replication 1

Residue Content, %	6.0	7.2	8.5	Design 7.5%
Bulk Specific Gravity	2.1762	2.1906	2.1779	---
Theoretical Specific Gravity	2.3981	2.3617	2.3245	---
Air Voids, %	9.3	7.3	6.3	7.0
V.M.A., %	20.2	20.5	22.0	21.0
Absorbed Asphalt, %	0.63	0.63	0.63	0.63
Effective Asphalt, %	5.37	6.57	7.87	6.87
Unit Weight, pcf	135.8	136.7	135.9	136.5
Stabilometer Value	37.5	29.0	20.3	27.0
Cohesimeter Value	474	401	239	360
Resilient Modulus, $10^3$ psi				
2-day	163	172	161	170
Final	449	329	310	320

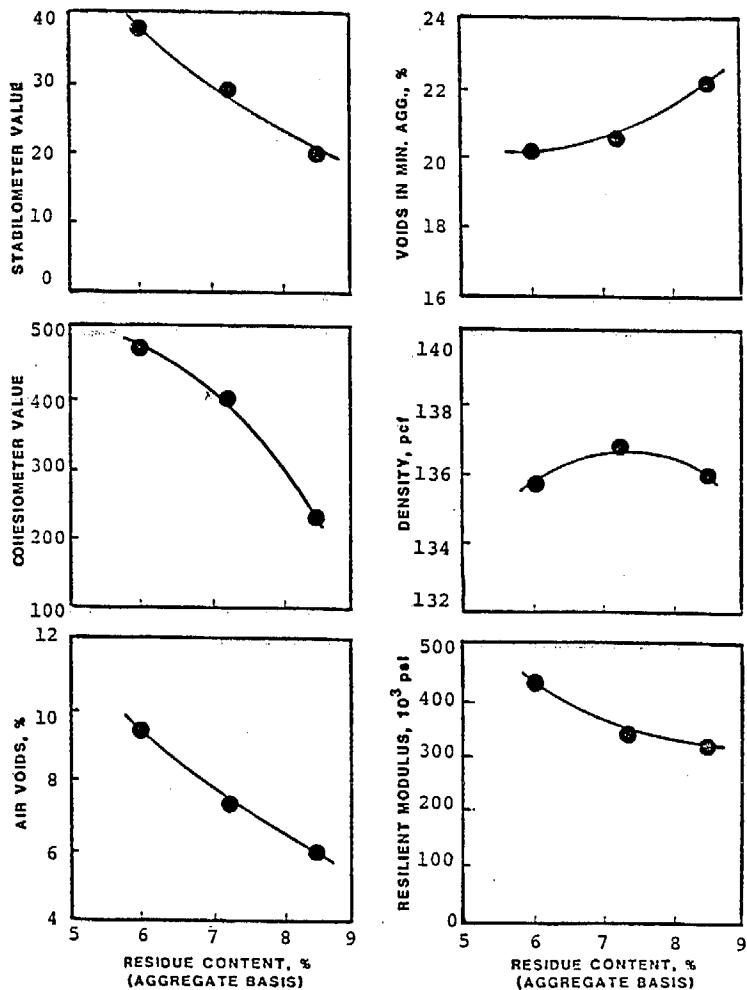


FIGURE B7. Mixture Design Data, San Bernardino,  
Low Quality, CSS-0, Replication 1

TABLE B8. Mixture Design Data, San Bernardino,  
Low Quality, CSS-0, Replication 2

Residue Content, %	6.0	7.2	8.5	Design 7.5%
Bulk Specific Gravity	2.1669	2.1873	2.1738	---
Theoretical Specific Gravity	2.3943	2.3581	2.3210	---
Air Voids, %	9.5	7.2	6.3	7.0
V.M.A., %	20.5	20.7	22.1	21.0
Absorbed Asphalt, %	0.55	0.55	0.55	0.55
Effective Asphalt, %	5.45	6.65	7.95	6.95
Unit Weight,pcf	135.2	136.5	135.6	136.5
Stabilometer Value	56.0	28.7	18.8	26.5
Cohesiometer Value	416	349	341	345
Resilient Modulus, $10^3$ psi				
2-day	195	191	187	190
Final	425	287	266	280

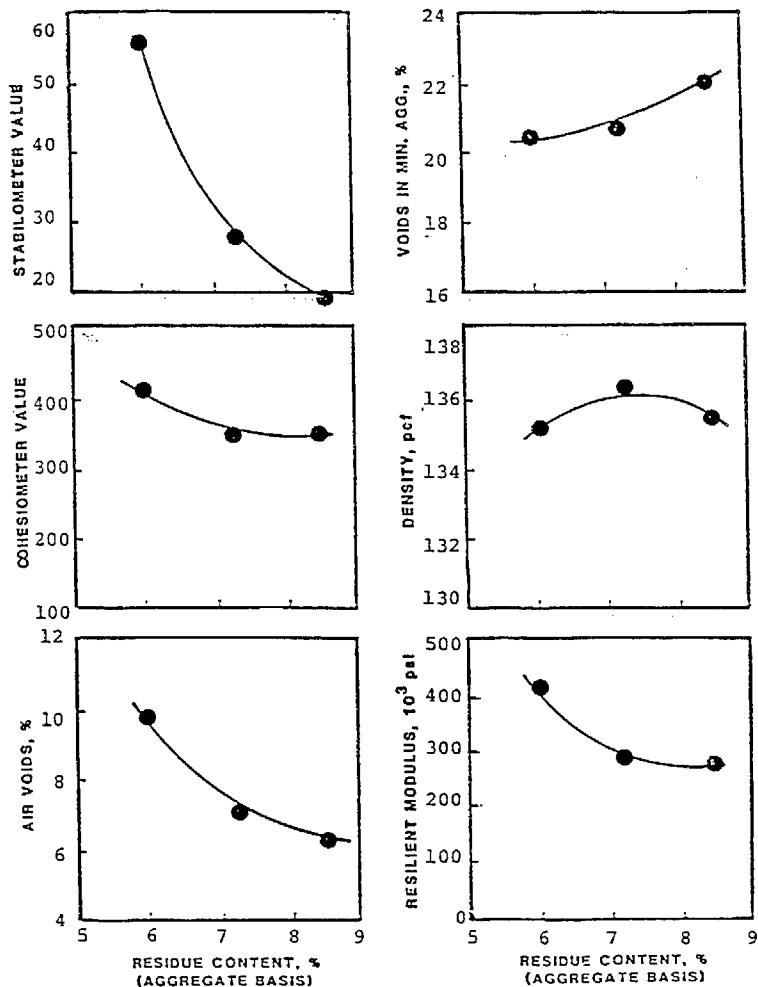


FIGURE B8. Mixture Design Data, San Bernardino,  
Low Quality, CSS-0, Replication 2

TABLE B9. Mixture Design Data, San Bernardino,  
Low Quality, CMS-0, Replication 1

Residue Content, %	6.0	7.2	8.5	Design 7.5%
Bulk Specific Gravity	2.1697	2.1368	2.1255	---
Theoretical Specific Gravity	2.3973	2.3610	2.3238	---
Air Voids, %	9.4	9.5	8.5	9.3
V.M.A., %	20.4	22.5	23.8	23.0
Absorbed Asphalt, %	0.61	0.61	0.61	0.61
Effective Asphalt, %	5.39	6.59	7.89	6.89
Unit Weight, pcf	135.4	133.3	132.6	133.0
Stabilometer Value	46.0	37.5	22.5	34.0
Cohesiometer Value	400	422	499	440
Resilient Modulus, $10^3$ psi				
2-day	159	185	185	185
Final	290	299	283	295

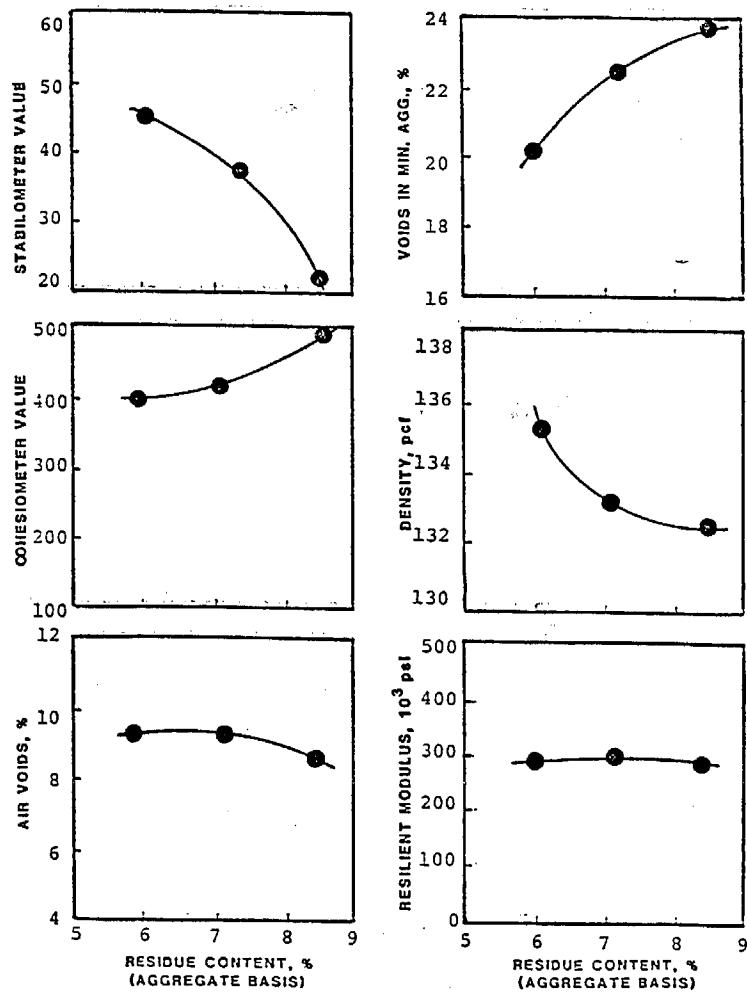


FIGURE B9. Mixture Design Data, San Bernardino,  
Low Quality, CMS-0, Replication 1

TABLE B10. Mixture Design Data, San Bernardino,  
Low Quality, CMS-0, Replication 2

Residue Content, %	6.0	7.2	8.5	Design 7.5%
Bulk Specific Gravity	2.1635	2.1481	2.1302	---
Theoretical Specific Gravity	2.4066	2.3699	2.3323	---
Air Voids, %	10.1	9.4	8.7	9.2
V.M.A., %	20.6	22.1	23.7	22.5
Absorbed Asphalt, %	0.78	0.78	0.78	0.78
Effective Asphalt, %	5.22	6.42	7.72	6.72
Unit Weight,pcf	135.0	134.1	132.9	133.8
Stabilometer Value	51.8	37.8	24.6	35.0
Cohesimeter Value	482	459	343	430
Resilient Modulus, $10^3$ psi				
2-day	151	150	162	155
Final	285	286	254	280

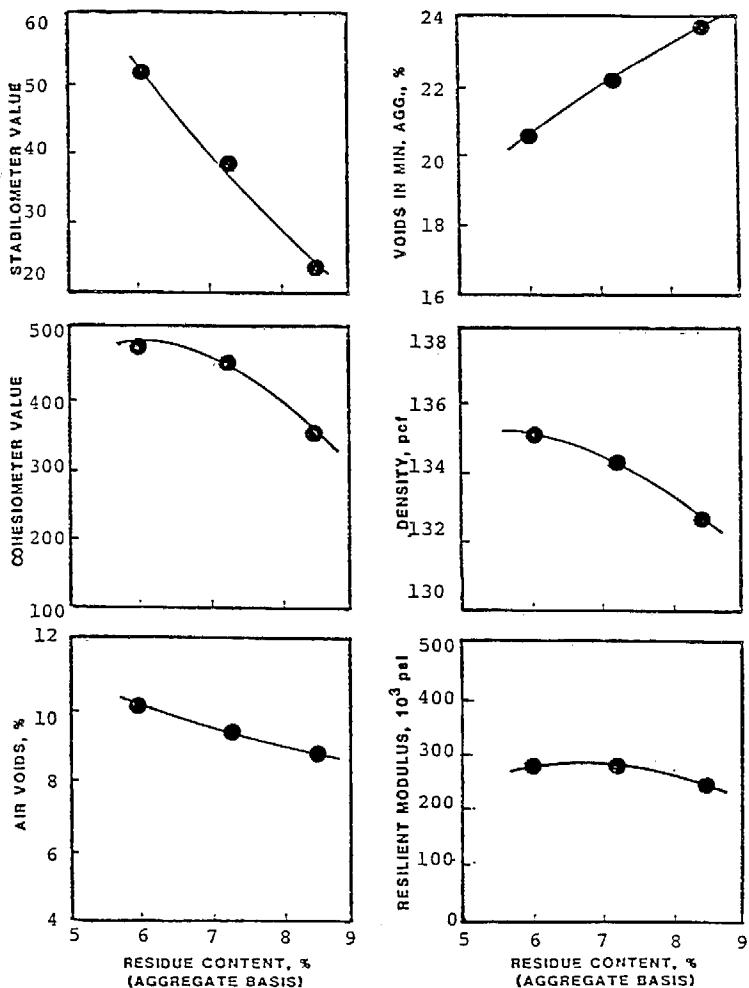


FIGURE B10. Mixture Design Data, San Bernardino,  
Low Quality, CMS-0, Replication 2

TABLE B11. Mixture Design Data, San Bernardino,  
Low Quality, CMS-7 Replication 1

Residue Content, %	6.0	7.2	8.5	Design 7.5%
Bulk Specific Gravity	2.1817	2.2108	2.1917	---
Theoretical Specific Gravity	2.3977	2.3601	2.3216	---
Air Voids, %	9.0	6.3	5.6	6.2
V.M.A., %	20.0	19.8	21.5	20.0
Absorbed Asphalt, %	0.72	0.72	0.72	0.72
Effective Asphalt, %	5.28	6.48	7.78	6.78
Unit Weight, pcf	136.1	138.0	136.8	137.5
Stabilometer Value	24.2	16.2	7.6	13.0
Cohesimeter Value	151	175	215	190
Resilient Modulus, $10^3$ psi				
2-day	52	63	41	55
Final	202	122	60	110

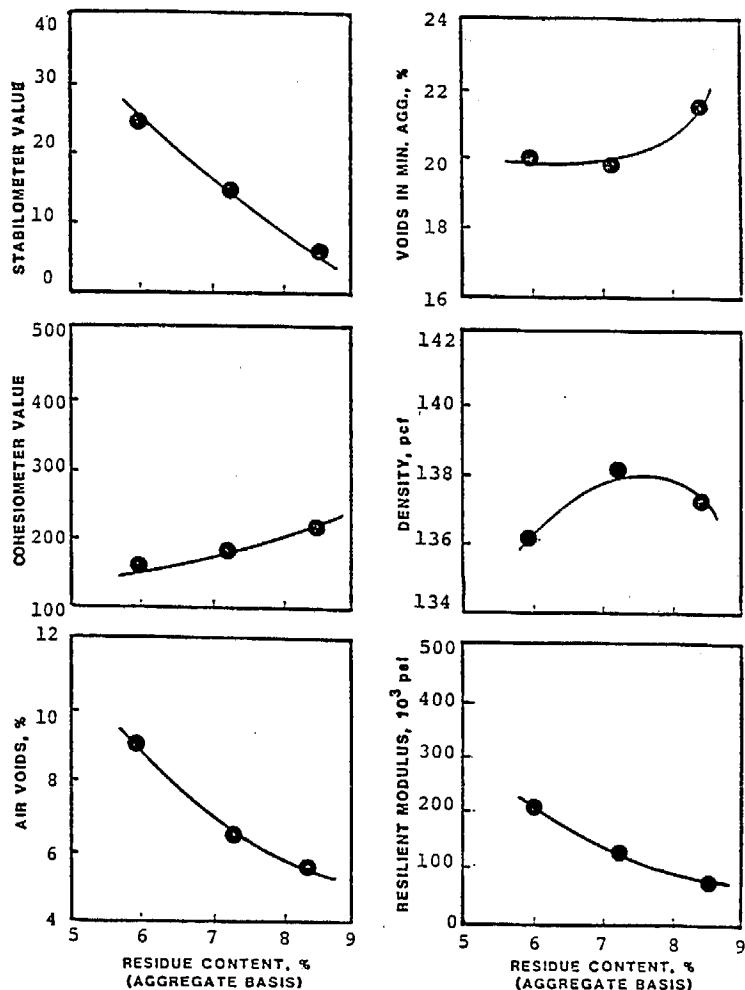


FIGURE B11. Mixture Design Data, San Bernardino,  
Low Quality, CMS-7 Replication 1

TABLE B12. Mixture Design Data, San Bernardino,  
Low Quality, CMS-7, Replication 2

Residue Content, %	6.0	7.2	8.5	<u>Design 7.5%</u>
Bulk Specific Gravity	2.2026	2.2062	2.1901	---
Theoretical Specific Gravity	2.4085	2.3705	2.3315	---
Air Voids, %	8.5	6.9	6.1	6.7
V.M.A., %	19.2	20.0	21.5	20.5
Absorbed Asphalt, %	0.92	0.92	0.92	0.92
Effective Asphalt, %	5.08	6.28	7.58	6.58
Unit Weight, pcf	137.4	137.7	136.7	137.5
Stabilometer Value	19.3	12.7	9.0	12.0
Cohesimeter Value	177	193	160	180
Resilient Modulus, $10^3$ psi				
2-day	63	53	32	48
Final	138	107	52	95

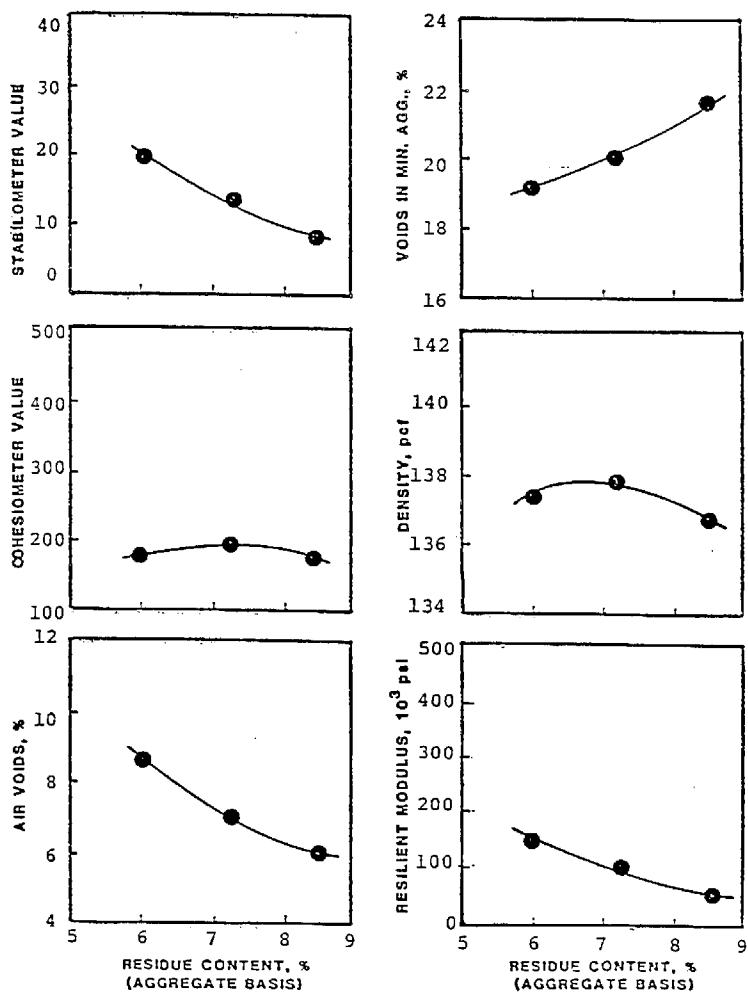


FIGURE B12. Mixture Design Data, San Bernardino,  
Low Quality, CMS-7, Replication 2

TABLE B13. Mixture Design Data, Fresno,  
High Quality, CSS-0, Replication 1

Residue Content, %	5.0	6.0	7.0	Design 7.0%
Bulk Specific Gravity	2.1789	2.1762	2.1872	---
Theoretical Specific Gravity	2.4250	2.3434	2.3632	---
Air Voids, %	10.1	9.1	7.5	7.5
V.M.A., %	16.4	17.3	17.7	17.7
Absorbed Asphalt, %	1.95	1.95	1.95	1.95
Effective Asphalt, %	3.05	4.05	5.05	5.05
Unit Weight, pcf	136.0	135.8	136.5	136.5
Stabilometer Value	51.3	56.7	39.3	39.3
Cohesimeter Value	330	284	280	280
Resilient Modulus, $10^3$ psi				
2-day	191	168	217	217
Final	282	434	482	482

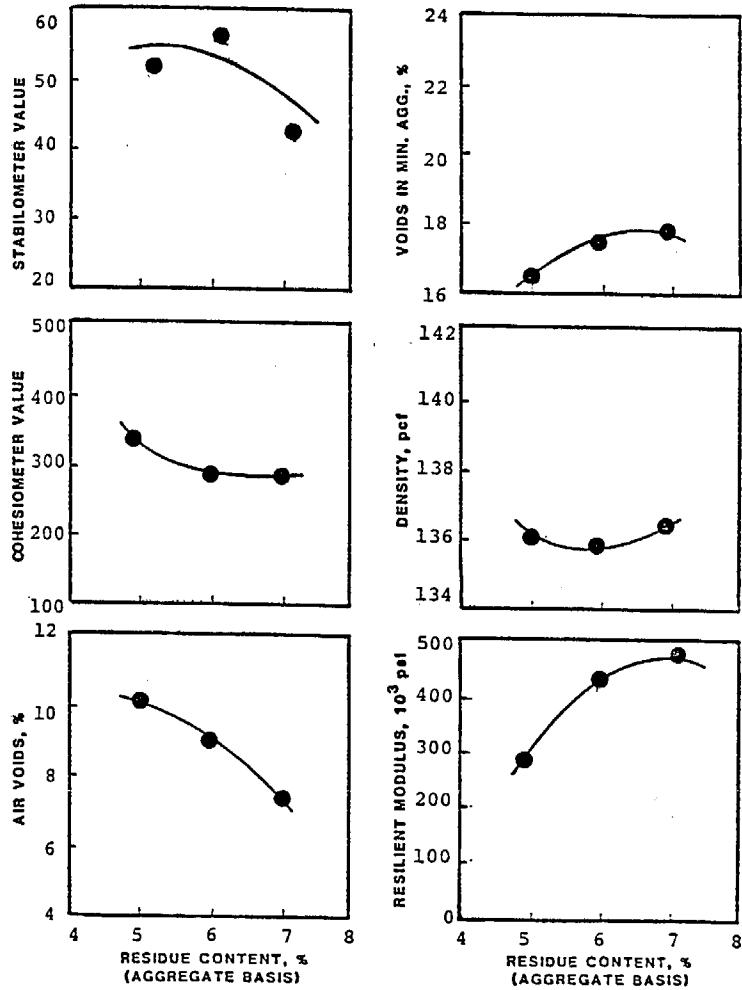


FIGURE B13. Mixture Design Data, Fresno,  
High Quality, CSS-0, Replication 1

TABLE B14. Mixture Design Data, Fresno,  
High Quality, CSS-0, Replication 2

Residue Content, %	5.0	6.0	7.0	<u>Design 7.0%</u>
Bulk Specific Gravity	2.1692	2.1677	2.1662	---
Theoretical Specific Gravity	2.4501	2.4176	2.3865	---
Air Voids, %	11.5	10.3	9.2	9.2
V.M.A., %	16.9	17.6	18.5	18.5
Absorbed Asphalt, %	2.40	2.40	2.40	2.40
Effective Asphalt, %	2.60	3.60	4.60	4.60
Unit Weight, pcf	135.4	135.3	135.2	135.2
Stabilometer Value	58.0	44.2	32.7	32.7
Cohesimeter Value	270	276	183	183
Resilient Modulus, $10^3$ psi				
2-day	149	173	191	191
Final	408	373	299	299

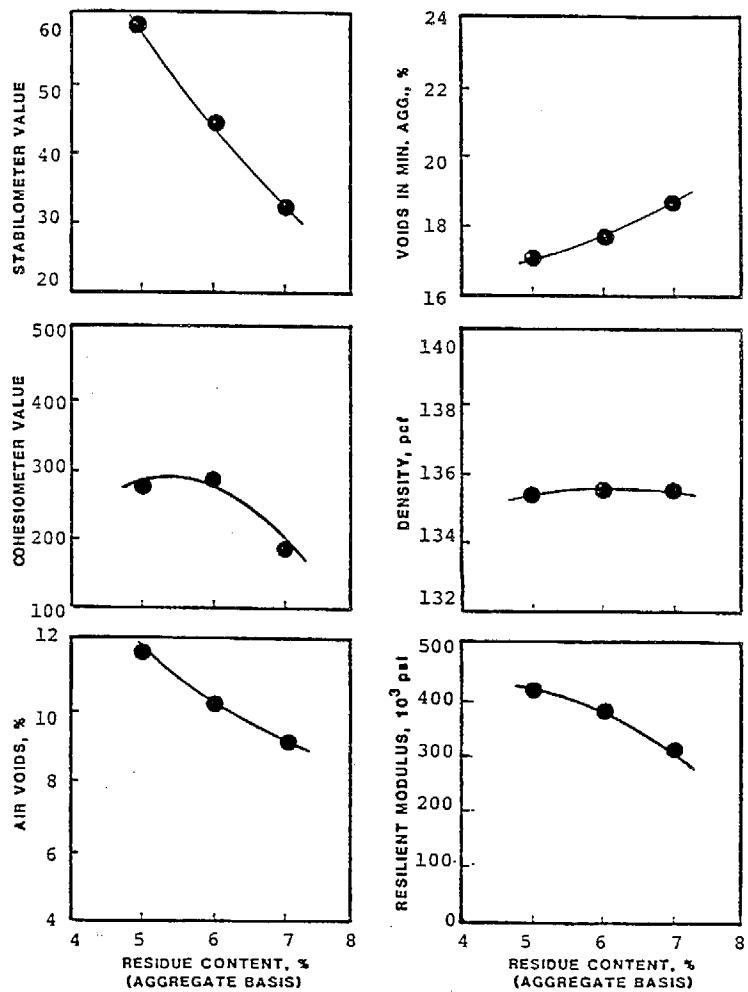


FIGURE B14. Mixture Design Data, Fresno,  
High Quality, CSS-0, Replication 2

TABLE B15. Mixture Design Data, Fresno,  
High Quality, CMS-0, Replication 1

Residue Content, %	5.0	6.0	7.0	Design 7.0%
Bulk Specific Gravity	2.1434	2.1755	2.1305	---
Theoretical Specific Gravity	2.4106	2.3795	2.3497	---
Air Voids, %	11.1	8.6	9.3	9.3
V.M.A., %	17.9	16.3	19.8	19.8
Absorbed Asphalt, %	1.69	1.69	1.69	1.69
Effective Asphalt, %	3.31	4.31	5.31	5.31
Unit Weight, pcf	133.7	133.6	132.9	132.9
Stabilometer Value	47.2	42.0	30.7	30.7
Cohesimeter Value	373	247	230	230
Resilient Modulus, $10^3$ psi				
2-day	175	180	155	155
Final	247	246	253	253

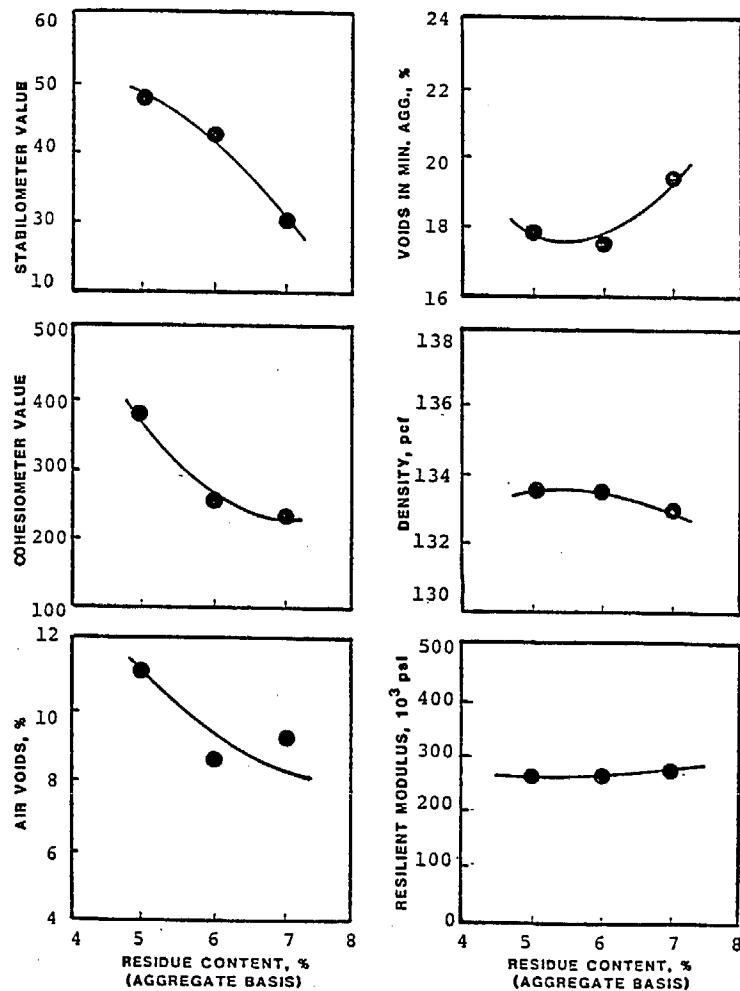


FIGURE B15. Mixture Design Data, Fresno,  
High Quality, CMS-0, Replication 1

TABLE Bl6. Mixture Design Data, Fresno,  
High Quality, CMS-0, Replication 2

Residue Content, %	5.0	6.0	7.0	Design 7.0%
Bulk Specific Gravity	2.1339	2.1398	2.1475	---
Theoretical Specific Gravity	2.4241	2.3925	2.3623	---
Air Voids, %	12.0	10.6	9.1	9.1
V.M.A., %	18.1	18.7	19.2	19.2
Absorbed Asphalt, %	1.94	1.94	1.94	1.94
Effective Asphalt, %	3.06	4.06	5.06	5.06
Unit Weight, pcf	133.1	133.5	134.0	134.0
Stabilometer Value	55.8	43.7	37.7	37.7
Cohesimeter Value	340	313	219	219
Resilient Modulus, $10^3$ psi				
2-day	149	152	154	154
Final	317	345	288	288

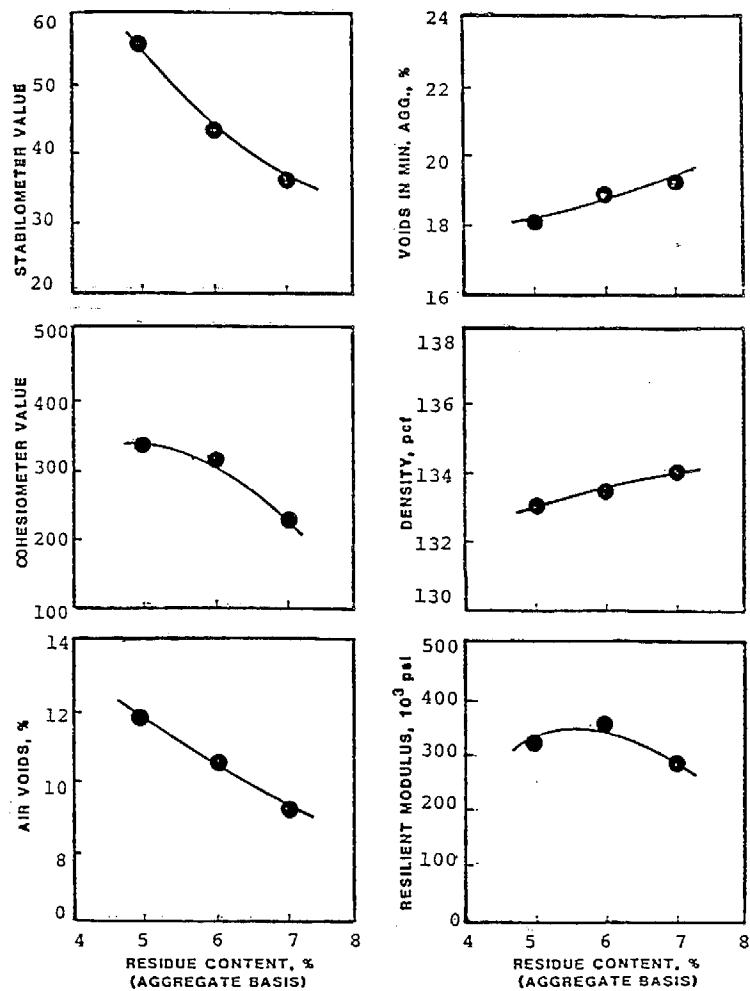


FIGURE Bl6. Mixture Design Data, Fresno,  
High Quality, CMS-0, Replication 2

TABLE B17. Mixture Design Data, Fresno,  
High Quality, CMS-7, Replication 1

Residue Content, %	5.0	6.0	7.0	Design 7.0 <sup>3</sup>
Bulk Specific Gravity	2.1959	2.2101	2.2128	---
Theoretical Specific Gravity	2.4539	2.4201	2.3879	---
Air Voids, %	10.5	8.7	7.3	7.3
V.M.A., %	15.8	16.0	16.7	16.7
Absorbed Asphalt, %	2.52	2.52	2.52	2.52
Effective Asphalt, %	2.48	3.48	4.48	4.48
Unit Weight,pcf	137.0	137.9	138.0	138.0
Stabilometer Value	46.7	37.0	21.3	21.3
Cohesiometer Value	289	147	122	122
Resilient Modulus, 10 <sup>3</sup> psi				
2-day	47	65	35	35
Final	294	214	75	75

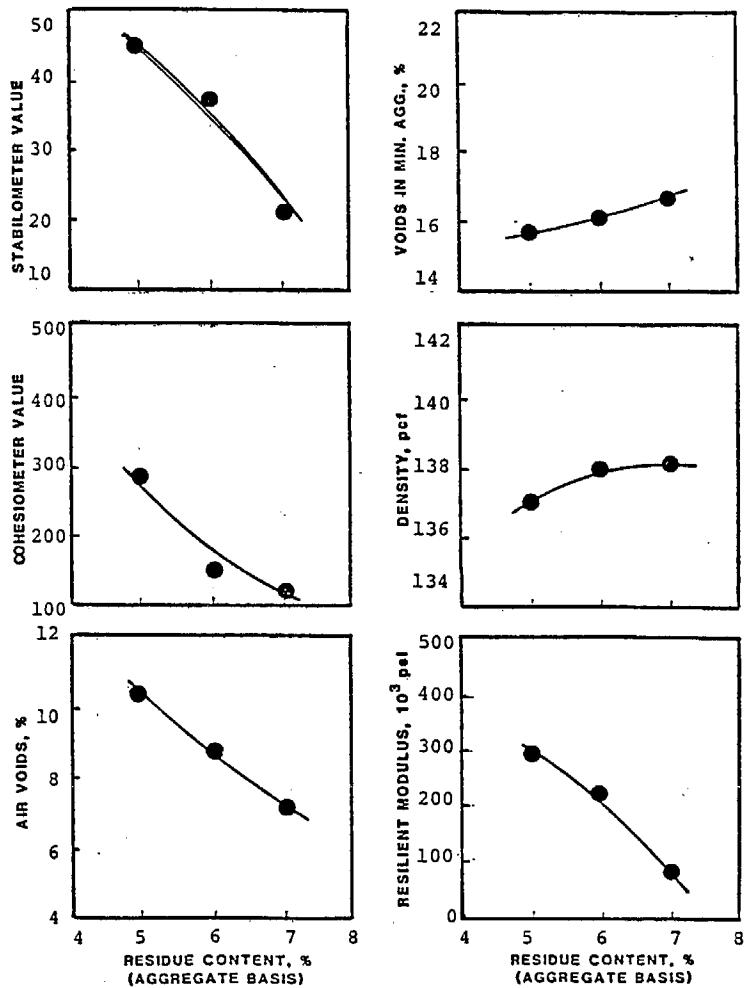


FIGURE B17. Mixture Design Data, Fresno,  
High Quality, CMS-7, Replication 1

TABLE B18. Mixture Design Data, Fresno,  
High Quality, CMS-7, Replication 2

Residue Content, %	5.0	6.0	7.0	Design 7.0%
Bulk Specific Gravity	2.2191	2.2285	2.2092	---
Theoretical Specific Gravity	2.4199	2.3874	2.3563	---
Air Voids, %	8.2	6.6	6.2	6.2
V.M.A., %	14.9	15.3	16.8	16.8
Absorbed Asphalt, %	1.92	1.92	1.92	1.92
Effective Asphalt, %	3.08	4.08	5.08	5.08
Unit Weight, pcf	138.5	139.1	137.9	137.9
Stabilometer Value	35.7	34.2	23.3	23.3
Cohesimeter Value	268	238	192	192
Resilient Modulus, $10^3$ psi				
2-day	75	84	63	63
Final	217	117	73	73

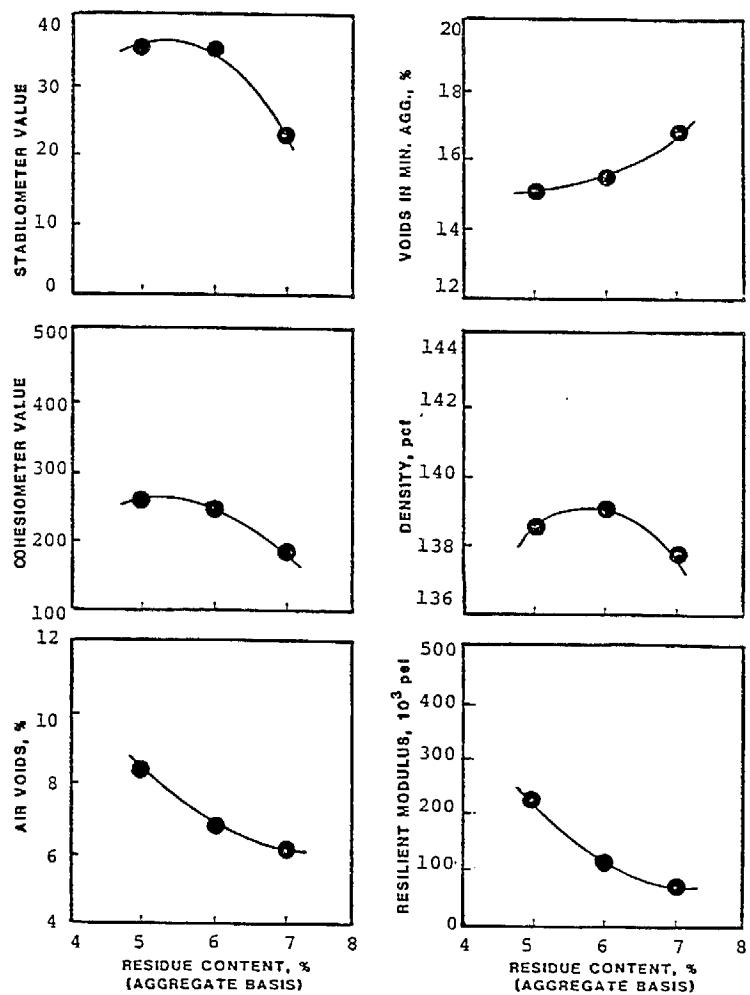


FIGURE B18. Mixture Design Data, Fresno,  
High Quality, CMS-7, Replication 2

TABLE B19. Mixture Design Data, Fresno,  
Low Quality, CSS-0, Replication 1

Residue Content, %	6.0	7.0	8.0	Design 7.5%
Bulk Specific Gravity	2.1698	2.1611	2.1514	---
Theoretical Specific Gravity	2.3803	2.3505	2.3220	---
Air Voids, %	8.9	8.1	7.3	7.7
V.M.A., %	17.5	18.6	19.8	19.2
Absorbed Asphalt, %	1.71	1.71	1.71	1.71
Effective Asphalt, %	4.29	5.29	6.29	6.79
Unit Weight, pcf	135.4	134.9	134.2	134.5
Stabilometer Value	51.3	39.8	35.9	38.0
Cohesimeter Value	506	449	481	465
Resilient Modulus, $10^3$ psi				
2-day	176	176	241	205
Final	312	383	353	365

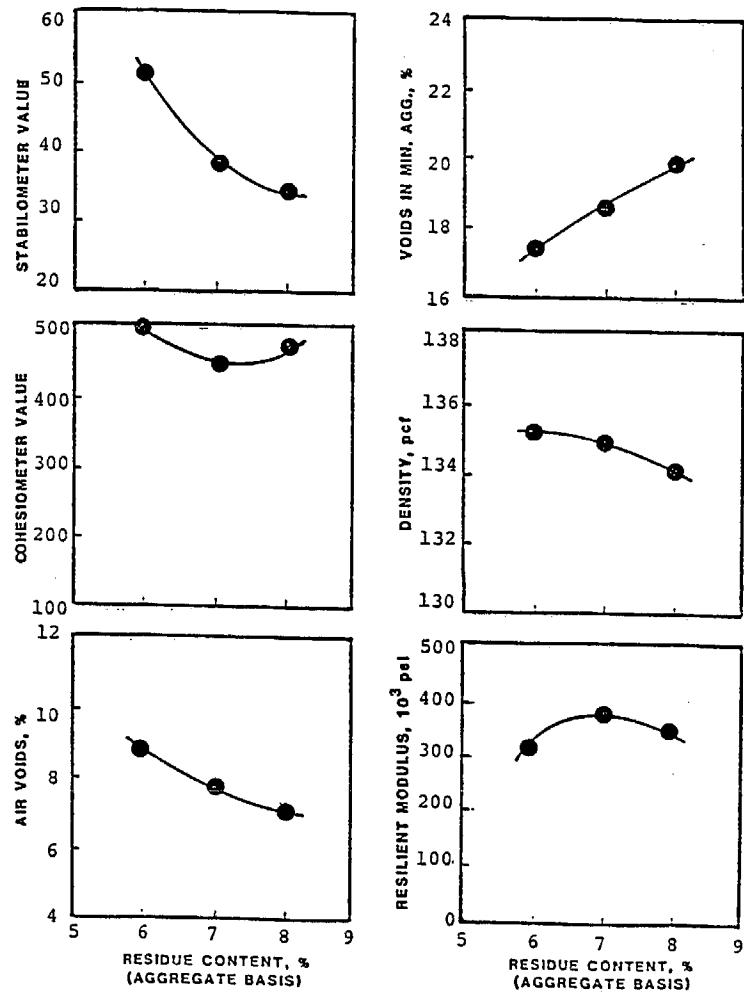


FIGURE B19. Mixture Design Data, Fresno,  
Low Quality, CSS-0, Replication 1

TABLE B20. Mixture Design Data, Fresno,  
Low Quality, CSS-0, Replication 2

Residue Content, %	6.0	7.0	8.0	Design 7.5%
Bulk Specific Gravity	2.1451	2.1476	2.1666	---
Theoretical Specific Gravity	2.3932	2.3629	2.3340	---
Air Voids, %	10.4	9.1	7.2	8.2
V.M.A., %	18.5	19.2	19.2	19.2
Absorbed Asphalt, %	1.94	1.94	1.94	1.94
Effective Asphalt, %	4.06	5.06	6.06	6.56
Unit Weight, pcf	133.9	134.0	135.2	134.5
Stabilometer Value	58.6	40.3	24.8	32.5
Cohesiometer Value	436	416	333	375
Resilient Modulus, $10^3$ psi				
2-day	147	179	186	182
Final	313	347	361	358

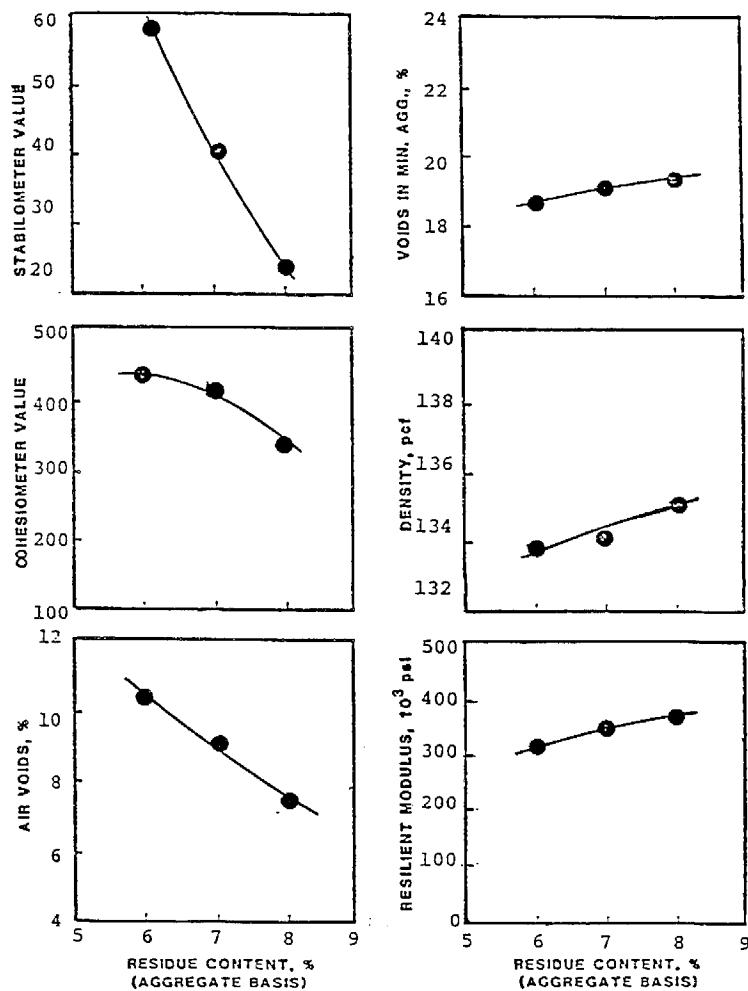


FIGURE B20. Mixture Design Data, Fresno,  
Low Quality, CSS-0, Replication 2

TABLE B21. Mixture Design Data, Fresno,  
Low Quality, CMS-0, Replication 1

Residue Content, %	6.0	7.0	8.0	Design 7.5%
Bulk Specific Gravity	2.1525	2.1406	2.1152	---
Theoretical Specific Gravity	2.3855	2.3555	2.3268	---
Air Voids, %	9.8	9.1	9.1	9.1
V.M.A., %	18.2	19.4	21.1	20.3
Absorbed Asphalt, %	1.80	1.80	1.80	1.80
Effective Asphalt, %	4.20	5.20	6.20	5.70
Unit Weight, pcf	134.3	133.6	133.0	133.5
Stabilometer Value	48.7	46.0	37.3	41.5
Cohesimeter Value	418	392	323	355
Resilient Modulus, $10^3$ psi				
2-day	188	177	200	190
Final	289	299	281	290

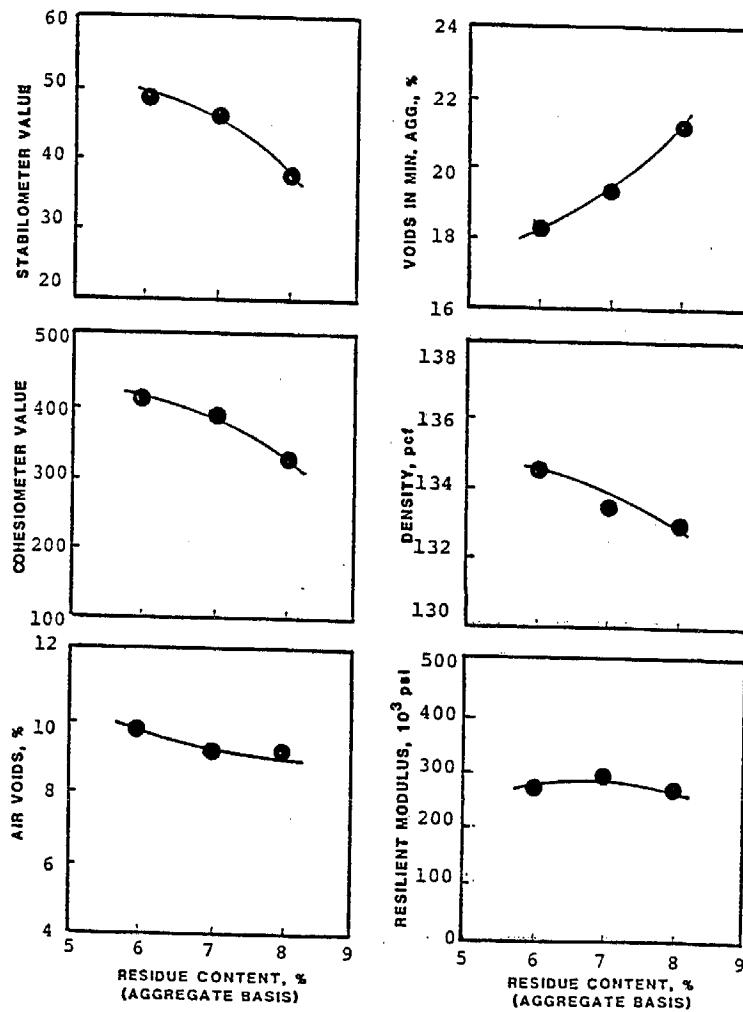


FIGURE B21. Mixture Design Data, Fresno,  
Low Quality, CMS-0, Replication 1

TABLE B22. Mixture Design Data, Fresno,  
Low Quality, CMS-0, Replication 2

Residue Content, %	5.5	6.5	7.5	Design 7.5%
Bulk Specific Gravity	2.1243	2.1164	2.1095	---
Theoretical Specific Gravity	2.3859	2.3557	2.3269	---
Air Voids, %	10.9	10.1	9.3	9.3
V.M.A., %	18.9	20.0	21.0	21.0
Absorbed Asphalt, %	1.52	1.52	1.52	1.52
Effective Asphalt, %	3.98	4.98	5.98	5.98
Unit Weight, pcf	132.6	132.1	131.6	131.6
Stabilometer Value	62.0	48.1	36.7	36.7
Cohesimeter Value	430	432	450	450
Resilient Modulus, $10^3$ psi				
2-day	160	180	171	171
Final	387	377	387	387

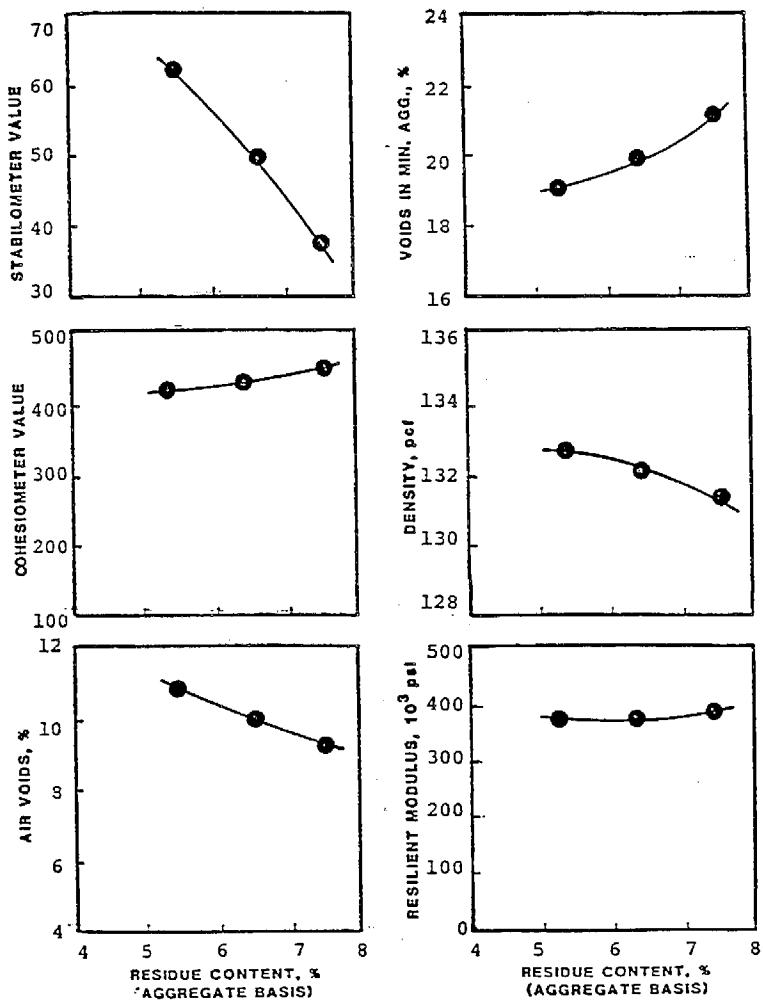


FIGURE B22. Mixture Design Data, Fresno,  
Low Quality, CMS-0, Replication 2

TABLE B23. Mixture Design Data, Fresno,  
Low Quality, CMS-7, Replication 1

Residue Content, %	6.0	7.0	8.0	Design 7.5%
Bulk Specific Gravity	2.1829	2.1981	2.1960	---
Theoretical Specific Gravity	2.3899	2.3587	2.3289	---
Air Voids, %	8.7	6.7	5.7	6.2
V.M.A., %	17.0	17.3	18.1	17.7
Absorbed Asphalt, %	1.97	1.97	1.97	1.97
Effective Asphalt, %	4.03	5.03	6.03	5.53
Unit Weight,pcf	136.2	137.2	137.0	137.0
Stabilometer Value	29.3	20.0	10.0	15.0
Cohesiometer Value	206	249	241	245
Resilient Modulus, $10^3$ psi				
2-day	84	76	69	73
Final	144	131	93	110

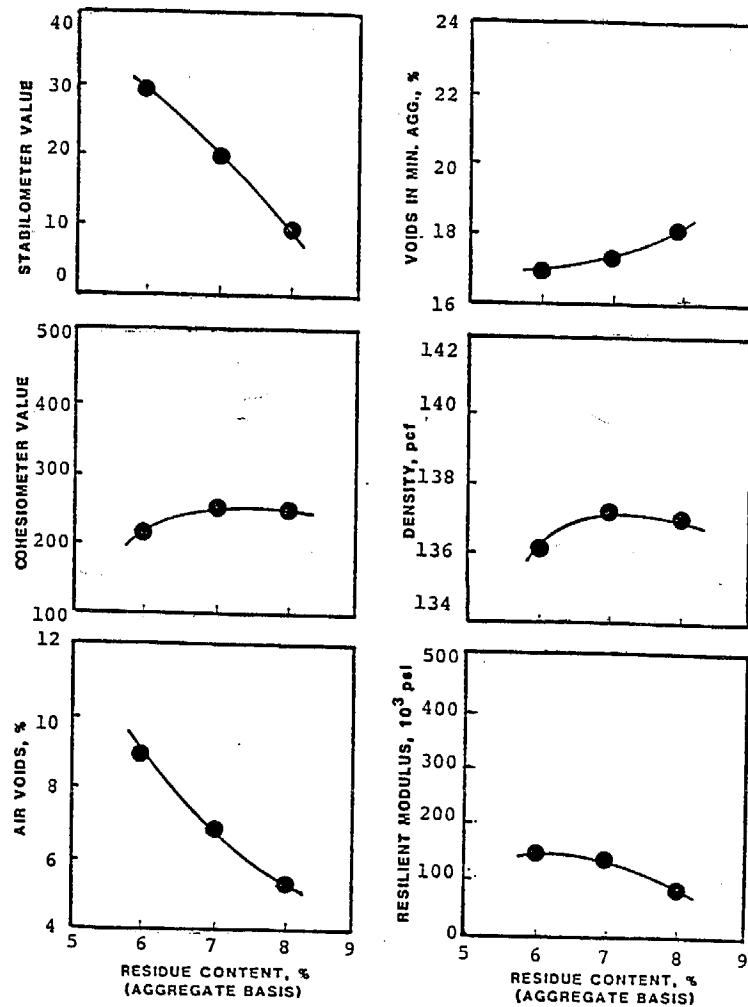


FIGURE B23. Mixture Design Data, Fresno,  
Low Quality, CMS-7, Replication 1

TABLE B24. Mixture Design Data, Fresno,  
Low Quality, CMS-7, Replication 2

Residue Content, %	6.0	7.0	8.0	Design 7.5%
Bulk Specific Gravity	2.1936	2.1850	2.1686	---
Theoretical Specific Gravity	2.3870	2.3559	2.3262	---
Air Voids, %	8.1	7.3	6.8	7.1
V.M.A., %	16.6	17.7	19.1	18.4
Absorbed Asphalt, %	1.91	1.91	1.91	1.91
Effective Asphalt, %	4.09	5.09	6.09	5.59
Unit Weight, pcf	136.9	136.4	135.3	136.0
Stabilometer Value	35.8	27.0	12.5	20.0
Cohesiometer Value	252	250	215	235
Resilient Modulus, $10^3$ psi				
2-day	84	77	77	77
Final	211	157	114	135

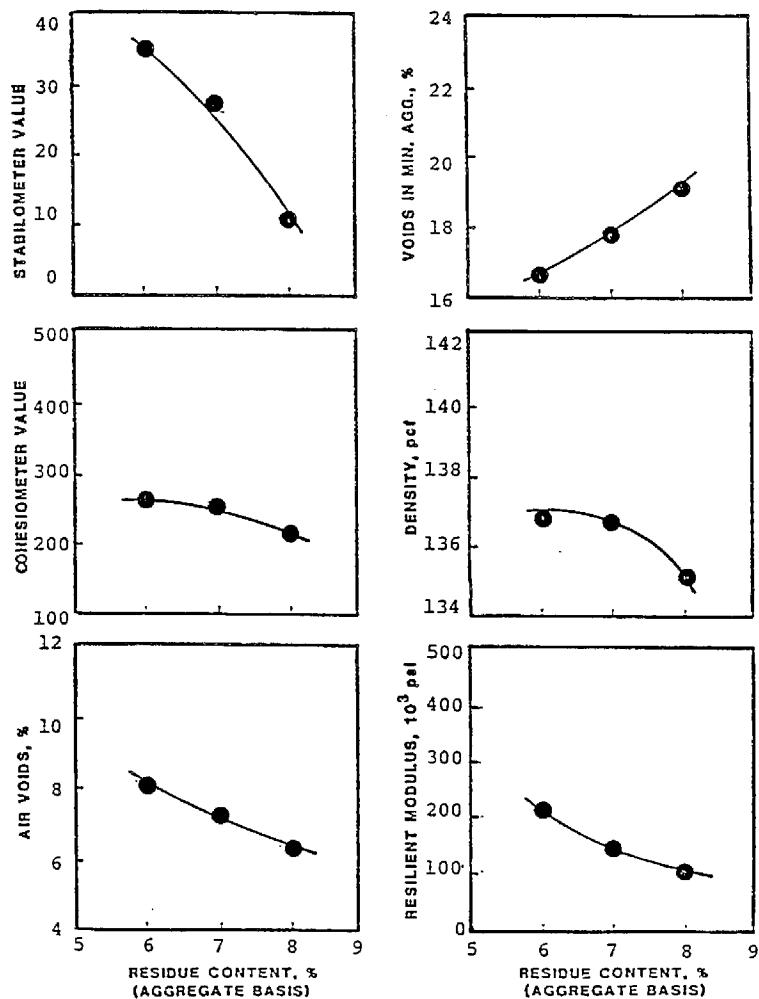


FIGURE B24. Mixture Design Data, Fresno,  
Low Quality, CMS-7, Replication 2

TABLE B25. Mixture Design Data, Graniterock,  
High Quality, CSS-0, Replication 1

Residue Content, %	4.7	5.7	6.7	Design 5.5%
Bulk Specific Gravity	2.3965	2.4521	2.4581	---
Theoretical Specific Gravity	2.6825	2.6411	2.6017	---
Air Voids, %	10.7	7.2	5.5	8.0
V.M.A., %	20.7	19.6	20.2	20.0
Absorbed Asphalt, %	.27	.27	.27	.27
Effective Asphalt, %	4.43	5.43	6.43	5.23
Unit Weight, pcf	149.5	153.0	153.4	152.0
Stabilometer Value	30.2	24.7	20.0	27
Cohesimeter Value	235	275	203	275
Resilient Modulus, $10^3$ psi				
2-day	158	164	116	160
Final	300	276	197	280

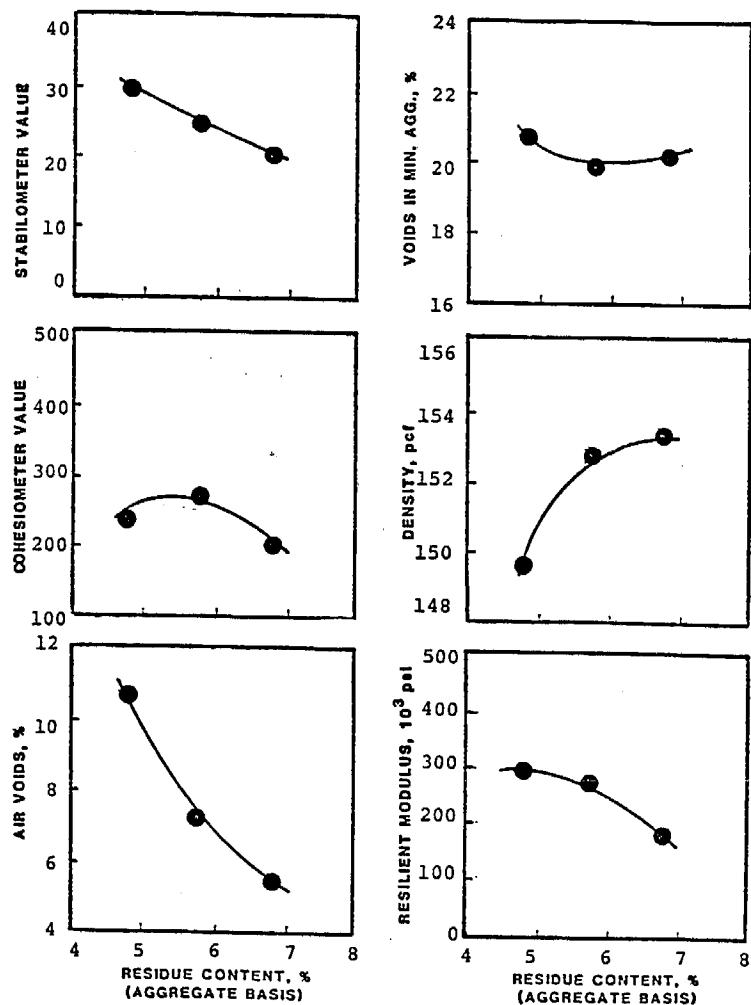


FIGURE B25. Mixture Design Data, Graniterock,  
High Quality, CSS-0, Replication 1

TABLE B26. Mixture Design Data, Graniterock,  
High Quality, CSS-0, Replication 2

Residue Content, %	4.7	5.7	6.7	Design 5.5%
Bulk Specific Gravity	2.4131	2.4573	2.4597	---
Theoretical Specific Gravity	2.6951	2.6532	2.6134	---
Air Voids, %	10.5	7.4	5.9	7.8
V.M.A., %	20.1	19.5	20.1	19.7
Absorbed Asphalt, %	.46	.46	.46	.46
Effective Asphalt, %	4.24	5.24	6.24	5.04
Unit Weight, pcf	150.6	153.3	153.5	152.5
Stabilometer Value	28.2	25.8	18.2	27.0
Cohesimeter Value	204	155	138	160
Resilient Modulus, $10^3$ psi				
2-day	115	143	126	130
Final	313	225	173	240

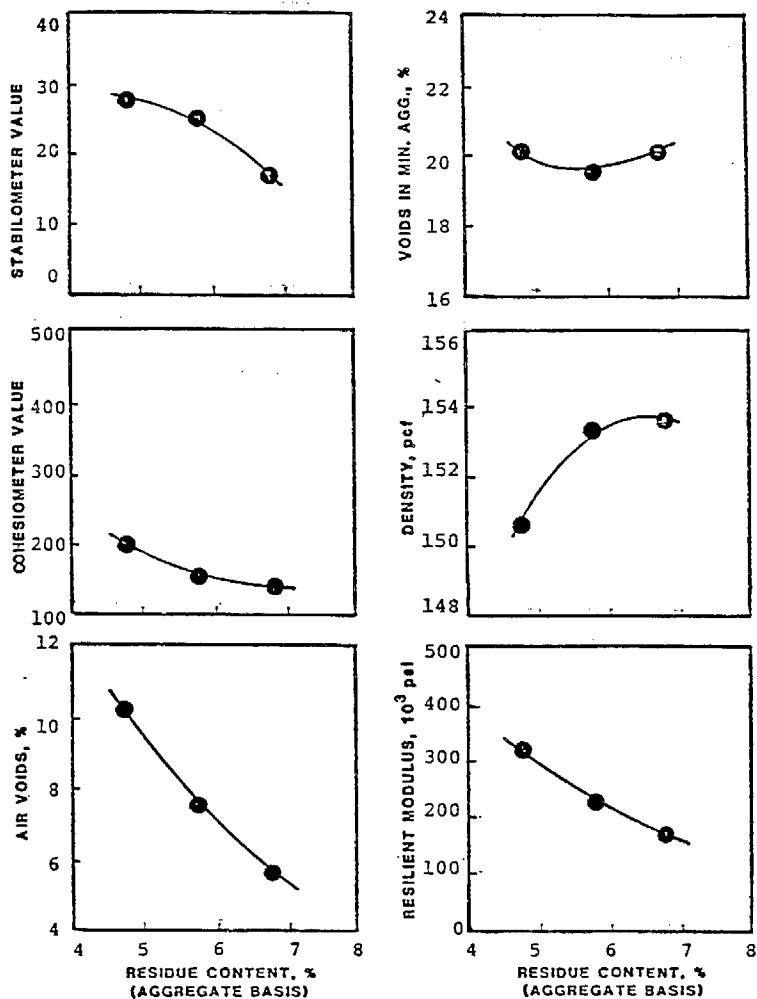


FIGURE B26. Mixture Design Data, Graniterock,  
High Quality, CSS-0, Replication 2

TABLE B27. Mixture Design Data, Graniterock,  
High Quality, CMS-0, Replication 1

Residue Content, %	4.7	5.7	6.7	<u>Design 5.5%</u>
Bulk Specific Gravity	2.3886	2.4116	2.4078	---
Theoretical Specific Gravity	2.6675	2.6267	2.5879	---
Air Voids, %	10.5	8.1	7.0	8.2
V.M.A., %	21.0	21.0	21.8	21.0
Absorbed Asphalt, %	0.05	0.05	0.05	0.05
Effective Asphalt, %	4.65	5.65	6.65	5.45
Unit Weight, pcf	149.1	150.5	150.2	150.5
Stabilometer Value	33.7	35.0	25.0	35.0
Cohesimeter Value	238	177	204	200
Resilient Modulus, $10^3$ psi				
2-day	104	144	150	140
Final	287	254	247	260

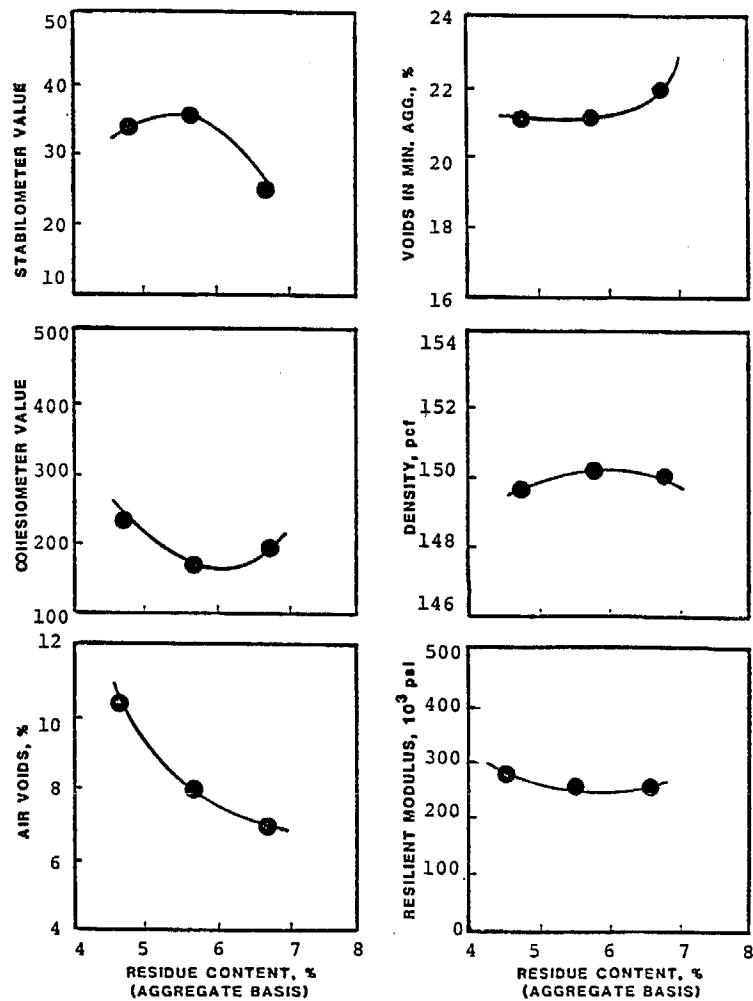


FIGURE B27. Mixture Design Data, Graniterock,  
High Quality, CMS-0, Replication 1

TABLE B28. Mixture Design Data, Graniterock,  
High Quality, CMS-0, Replication 2

Residue Content, %	4.7	5.7	6.7	<u>Design 5.5%</u>
Bulk Specific Gravity	2.3861	2.4025	2.3925	---
Theoretical Specific Gravity	2.6649	2.6242	2.5855	---
Air Voids, %	10.5	8.5	7.5	8.7
V.M.A., %	20.7	21.0	22.0	2.09
Absorbed Asphalt, %	0.14	0.14	0.14	0.14
Effective Asphalt, %	4.56	5.56	6.56	5.36
Unit Weight, pcf	148.9	149.9	149.3	149.0
Stabilometer Value	33.8	28.3	22.0	30.0
Cohesimeter Value	145	135	129	140
Resilient Modulus, $10^3$ psi				
2-day	124	135	142	130
Final	307	307	277	307

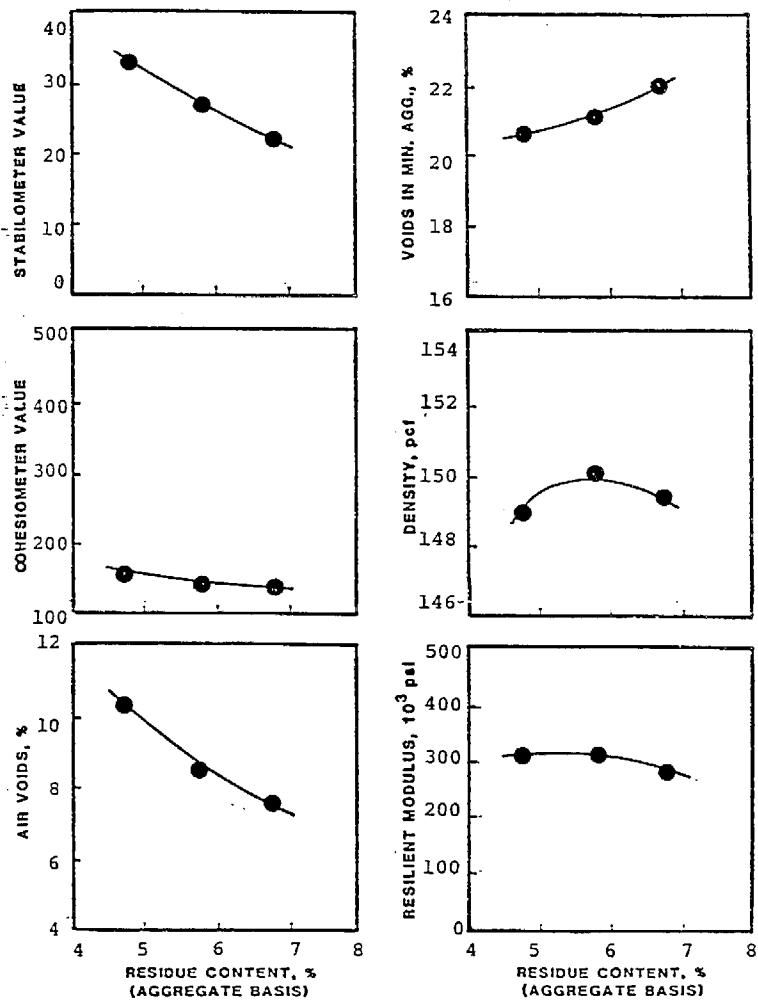


FIGURE B28. Mixture Design Data, Graniterock,  
High Quality, CMS-0, Replication 2

TABLE B29. Mixture Design Data, Graniterock,  
High Quality, CMS-7, Replication 1

Residue Content, %	4.7	5.7	6.7	Design 5.5%
Bulk Specific Gravity	2.4618	2.4637	2.4728	---
Theoretical Specific Gravity	2.6905	2.6475	2.6066	---
Air Voids, %	8.4	6.9	5.1	7.1
V.M.A., %	18.5	19.2	19.7	19.0
Absorbed Asphalt, %	0.47	0.47	0.47	0.47
Effective Asphalt, %	4.23	5.23	6.23	5.03
Unit Weight, pcf	153.6	153.7	154.3	153.7
Stabilometer Value	41.0	33.0	19.8	35.0
Cohesiometer Value	166	120	131	130
Resilient Modulus, $10^3$ psi				
2-day	46	35	30	38
Final	158	56	28	80

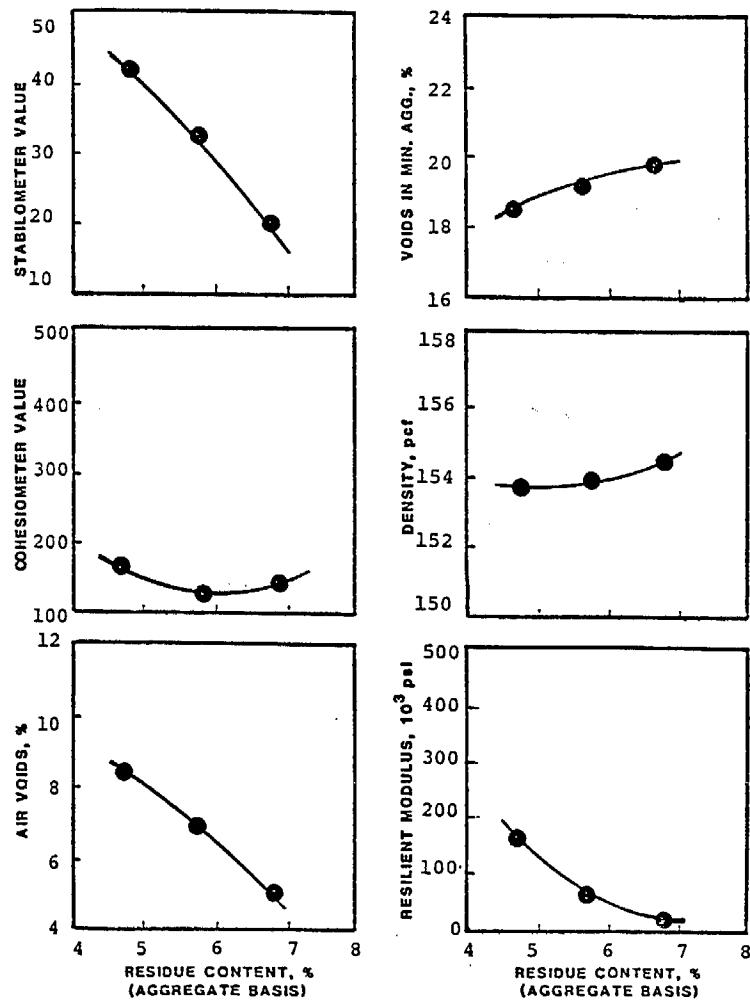


FIGURE B29. Mixture Design Data, Graniterock,  
High Quality, CMS-7, Replication 1

TABLE B30. Mixture Design Data, Graniterock,  
High Quality, CMS-7, Replication 2

Residue Content, %	4-7	5-7	6-7	Design 5.5%
Bulk Specific Gravity	2.4519	2.4638	2.4706	---
Theoretical Specific Gravity	2.6609	2.6265	2.5793	---
Air Voids, %	7.9	6.2	4.2	6.5
V.M.A., %	18.9	19.2	19.8	19.1
Absorbed Asphalt, %	0.05	0.05	0.05	0.05
Effective Asphalt, %	4.65	5.65	6.65	5.45
Unit Weight, pcf	153.0	153.7	154.2	153.5
Stabilometer Value	42.0	32.7	24.7	35.0
Cohesiometer Value	126	114	182	120
Resilient Modulus, $10^3$ psi				
2-day	47	43	29	45
Final	144	79	33	90

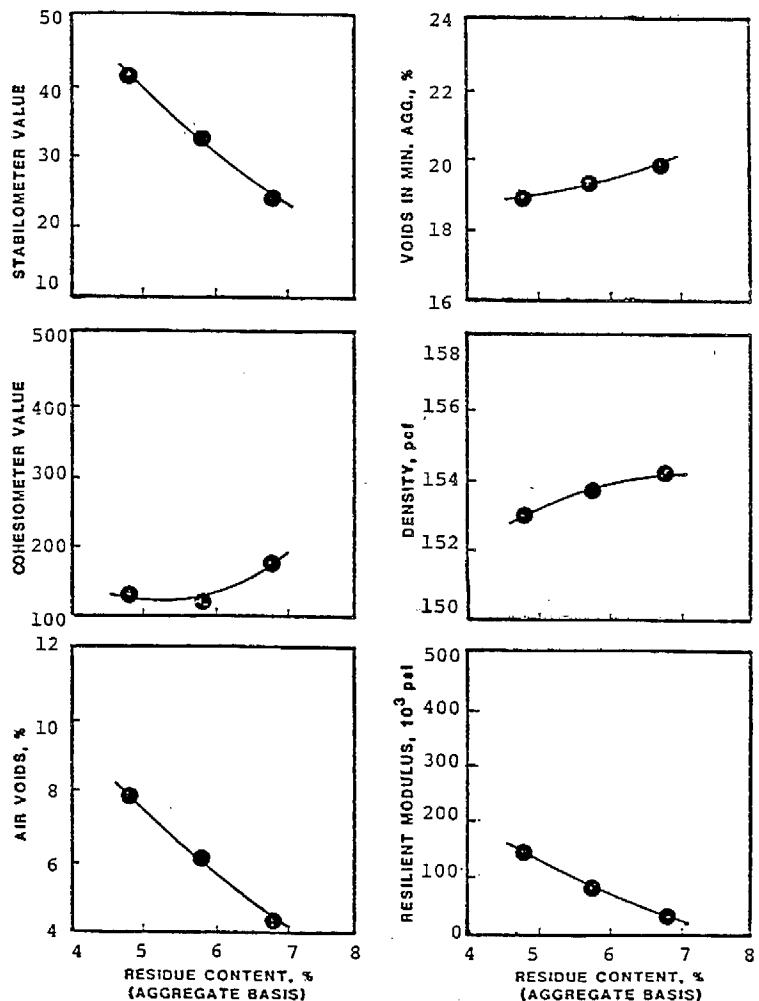


FIGURE B30. Mixture Design Data, Graniterock,  
High Quality, CMS-7, Replication 2

TABLE B31. Mixture Design Data, Graniterock,  
Low Quality, CSS-0, Replication 1

Residue Content, %	5.5	6.5	7.5	<u>Design 6.0%</u>
Bulk Specific Gravity	2.4268	2.4286	2.4206	---
Theoretical Specific Gravity	2.6358	2.5966	2.5592	---
Air Voids, %	8.0	6.5	5.4	7.2
V.M.A., %	20.0	20.7	21.7	20.4
Absorbed Asphalt, %	0.20	0.20	0.20	0.20
Effective Asphalt, %	5.30	6.30	7.30	5.80
Unit Weight,pcf	151.5	151.5	151.1	151.5
Stabilometer Value	28.0	19.2	9.0	23.5
Cohesiometer Value	268	233	193	250
Resilient Modulus, $10^3$ psi				
2-day	182	169	145	175
Final	338	308	250	320

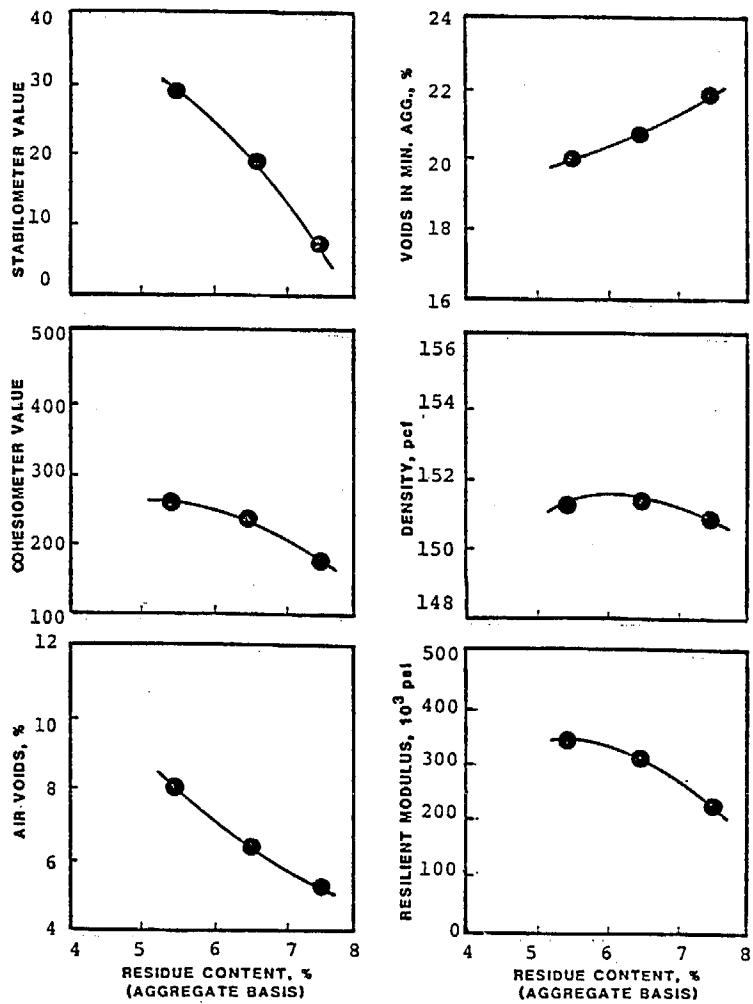


FIGURE B31. Mixture Design Data, Graniterock,  
Low Quality, CSS-0, Replication 1

TABLE B32. Mixture Design Data, Graniterock  
Low Quality, CSS-0, Replication 2

Residue Content, %	5.5	6.5	7.5	<u>Design 6.0%</u>
Bulk Specific Gravity	2.4329	2.4246	2.4077	---
Theoretical Specific Gravity	2.6401	2.6007	2.5632	---
Air Voids, %	7.9	6.8	6.1	7.3
V.M.A., %	19.8	20.8	22.1	20.3
Absorbed Asphalt, %	0.27	0.27	0.27	0.27
Effective Asphalt, %	5.23	6.23	7.23	5.73
Unit Weight, pcf	151.8	151.3	150.2	151.5
Stabilometer Value	20.3	16.5	11.0	18.5
Cohesimeter Value	243	215	205	225
Resilient Modulus, $10^3$ psi				
2-day	201	168	184	185
Final	354	340	272	345

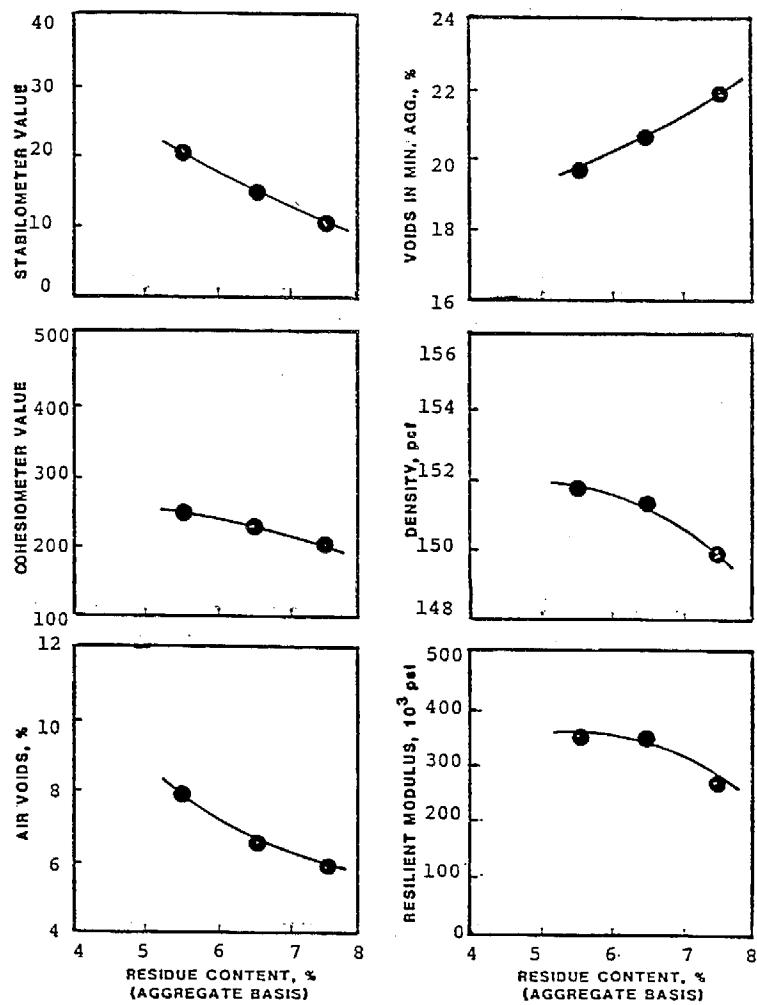


FIGURE B32. Mixture Design Data, Graniterock,  
Low Quality, CSS-0, Replication 2

TABLE B33. Mixture Design Data, Graniterock,  
Low Quality, CMS-0, Replication 1

Residue Content, %	<u>5.5</u>	<u>6.5</u>	<u>7.5</u>	Design 6.0%
Bulk Specific Gravity	2.3824	<b>2.3896</b>	2.3701	---
Theoretical Specific Gravity	2.6318	2.5928	2.5555	---
Air Voids, %	9.5	7.8	7.3	8.4
V.M.A., %	21.5	22.0	23.3	21.8
Absorbed Asphalt, %	0.14	0.14	0.14	0.14
Effective Asphalt, %	5.36	6.36	7.36	5.86
Unit Weight,pcf	148.7	149.1	147.9	149.0
Stabilometer Value	28.7	19.5	16.1	24.0
Cohesiometer Value	381	265	212	320
Resilient Modulus, $10^3$ psi				
2-day	224	212	196	215
Final	380	404	341	395

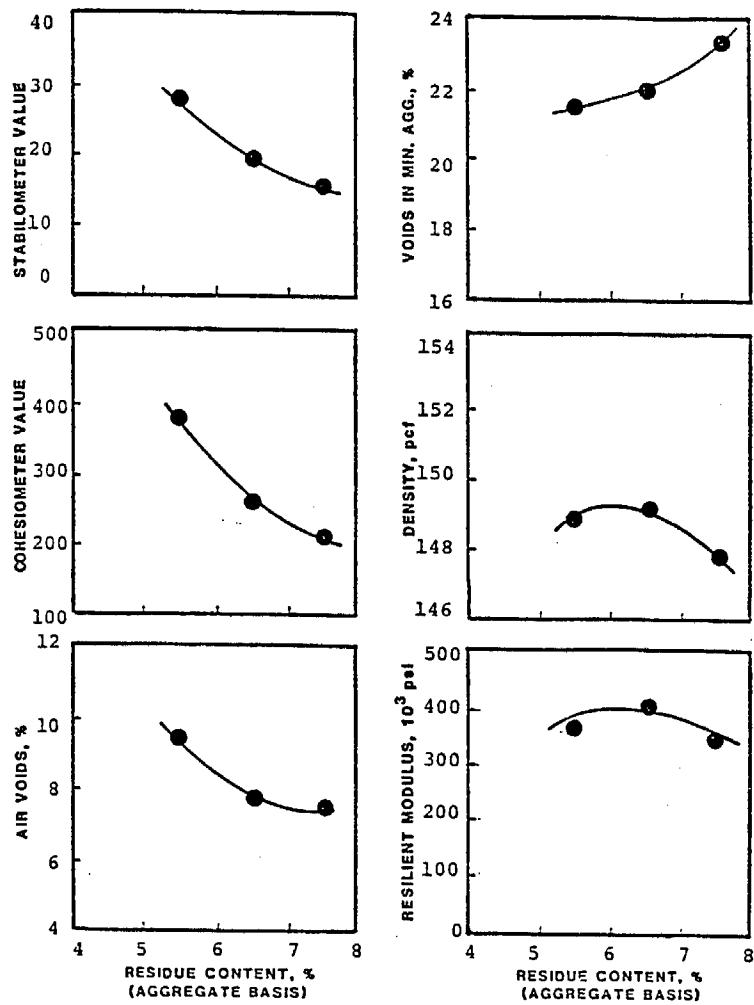


FIGURE B33. Mixture Design Data, Graniterock,  
Low Quality, CMS-0, Replication 1

TABLE B34. Mixture Design Data, Graniterock,  
Low Quality, CMS-0, Replication 2

Residue Content, %	5.5	6.5	7.5	<u>Design 6.0%</u>
Bulk Specific Gravity	2.3834	2.3784	2.3628	---
Theoretical Specific Gravity	2.6371	2.5978	2.5604	---
Air Voids, %	9.6	8.4	7.7	9.0
V.M.A., %	21.4	22.3	23.6	21.8
Absorbed Asphalt, %	0.22	0.22	0.22	0.22
Effective Asphalt, %	5.28	6.28	7.28	5.78
Unit Weight, pcf	148.7	148.4	147.4	148.5
Stabilometer Value	27.9	20.8	16.7	24.5
Cohesimeter Value	207	270	334	240
Resilient Modulus, $10^3$ psi				
2-day	176	185	181	180
Final	332	336	350	334

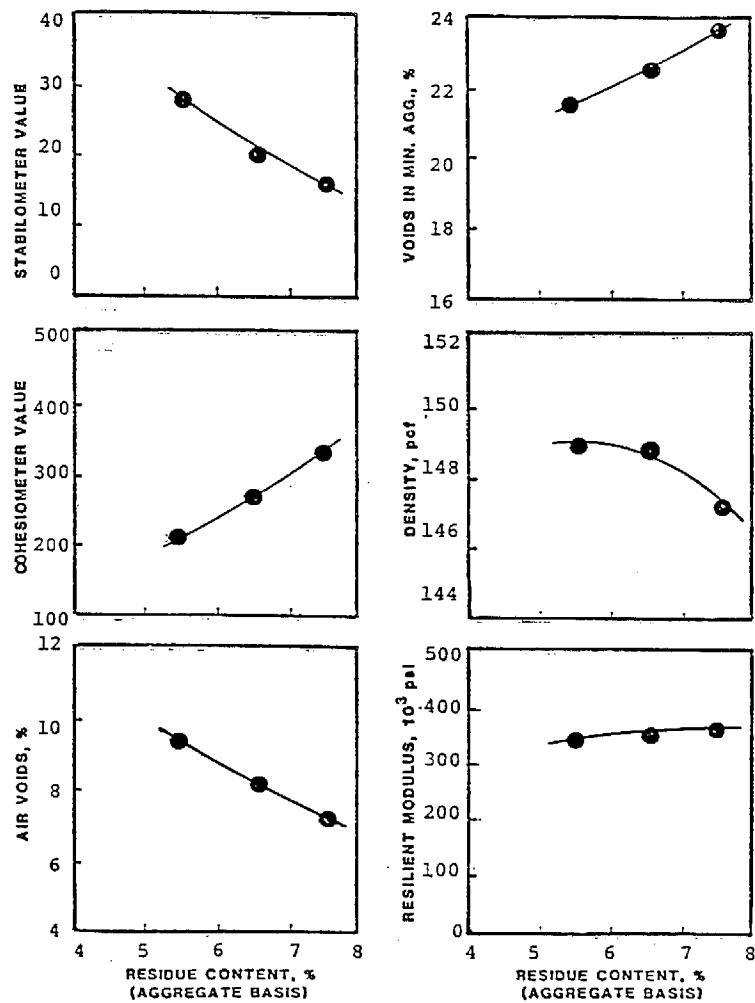


FIGURE B34. Mixture Design Data, Graniterock,  
Low Quality, CMS-0, Replication 2

TABLE B35. Mixture Design Data, Graniterock,  
Low Quality, CMS-7, Replication 1

Residue Content, %	5.5	6.5	7.5	<u>Design 6.0%</u>
Bulk Specific Gravity	2.4720	2.4720	2.4515	---
Theoretical Specific Gravity	2.6164	2.5767	2.5388	---
Air Voids, %	5.5	4.0	3.4	4.8
V.M.A., %	18.5	19.3	20.7	18.9
Absorbed Asphalt, %	0.01	0.01	0.01	0.01
Effective Asphalt, %	5.49	6.49	7.49	5.99
Unit Weight, pcf	154.3	154.3	153.0	154.3
Stabilometer Value	29.3	20.5	9.7	25.0
Cohesimeter Value	174	156	283	170
Resilient Modulus, $10^3$ psi				
2-day	69	46	22	55
Final	153	72	50	110

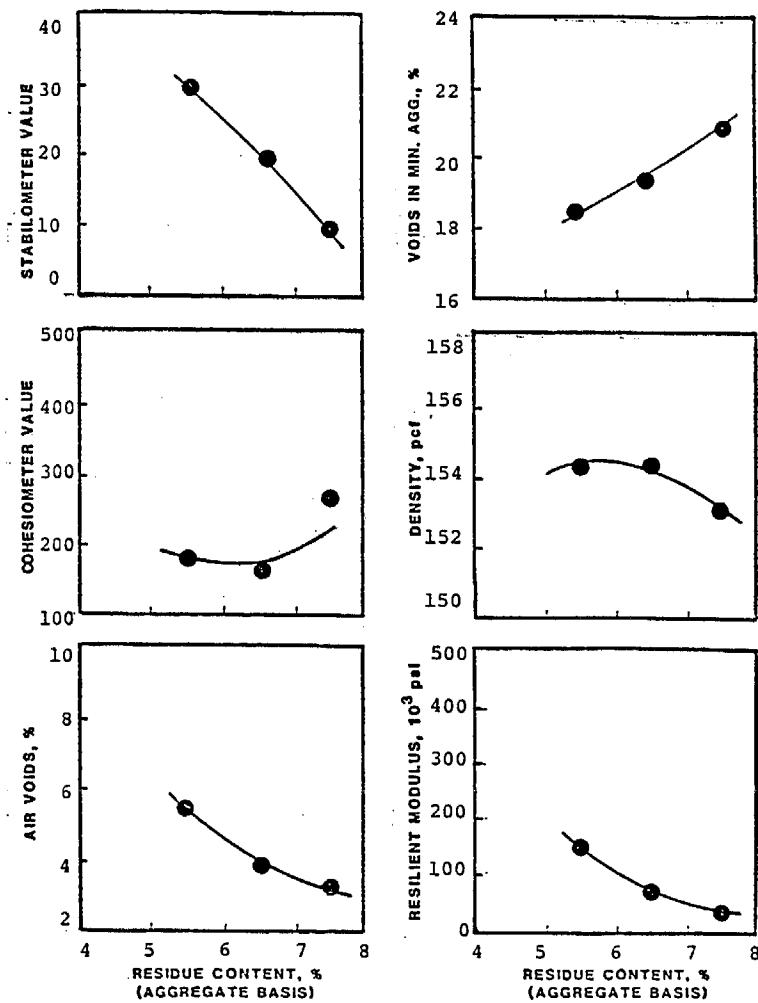


FIGURE B35. Mixture Design Data, Graniterock,  
Low Quality, CMS-7, Replication 1

TABLE B36. Mixture Design Data, Graniterock,  
Low Quality, CMS-7, Replication 2

Residue Content, %	5.5	6.5	7.5	Design 6.0%
Bulk Specific Gravity	2.4816	2.4721	2.4560	---
Theoretical Specific Gravity	2.6389	2.5983	2.5596	---
Air Voids, %	6.0	4.9	4.0	5.5
V.M.A., %	18.2	19.3	20.5	18.7
Absorbed Asphalt, %	0.35	0.35	0.35	0.35
Effective Asphalt, %	5.15	6.15	7.15	5.65
Unit Weight, pcf	154.8	154.3	153.3	154.5
Stabilometer Value	29.8	19.3	13.0	25.0
Cohesimeter Value	188	157	118	180
Resilient Modulus, $10^3$ psi				
2-day	92	43	27	65
Final	186	79	46	135

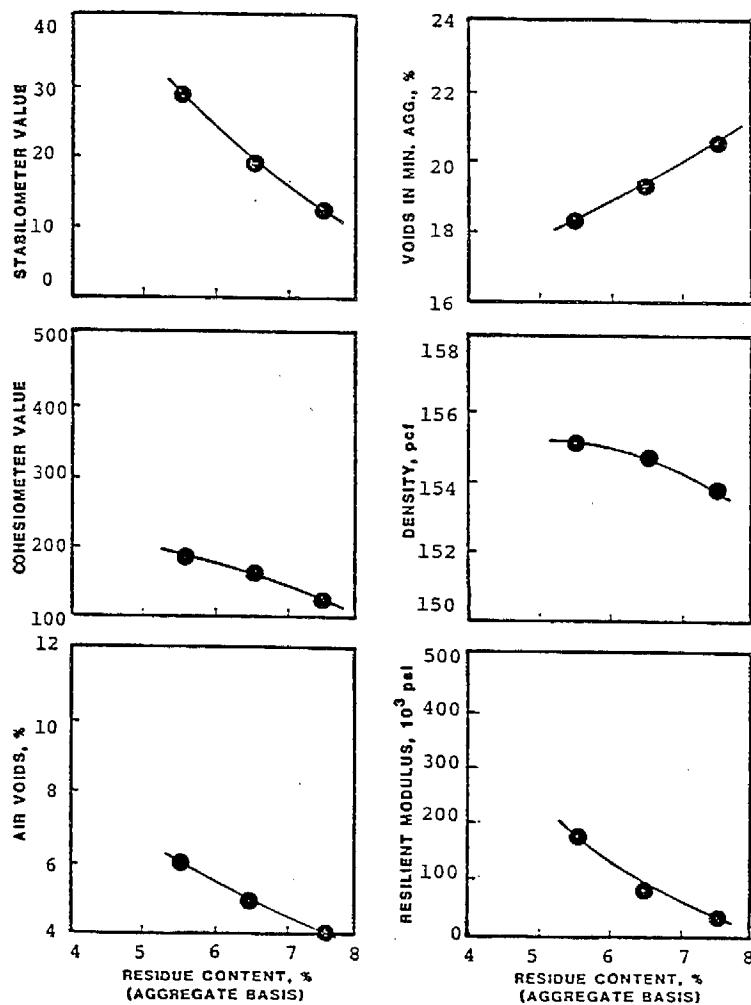


FIGURE B36. Mixture Design Data, Graniterock,  
Low Quality, CMS-7, Replication 2

Table B37. Mixture Design Data, San Bernardino,  
High Quality, SS-15% SEA, Replication 1

Equivalent Residue Content, %	6.0	7.0	8.0	Design 7.0 %
Residue Content, %	6.30	7.35	8.40	Design 7.35 %
Bulk Specific Gravity	2.1584	2.1570	2.1385	-
Theoretical Specific Gravity	2.4451	2.4143	2.3848	-
Air Voids, %	11.7	10.7	10.3	10.7
V.M.A., %	21.0	21.9	23.3	21.9
Absorbed Asphalt, %	1.40	1.40	1.40	1.40
Effective Asphalt, %	4.60	5.60	6.60	5.60
Unit Weight, pcf	134.7	134.6	133.4	134.6
Stabilometer Value	41.5	48.8	38.2	48.8
Cohesimeter Value	208	61	63	63
Resilient Modulus, $10^3$ psi				
2-day	96	141	126	141
Final	339	325	299	325

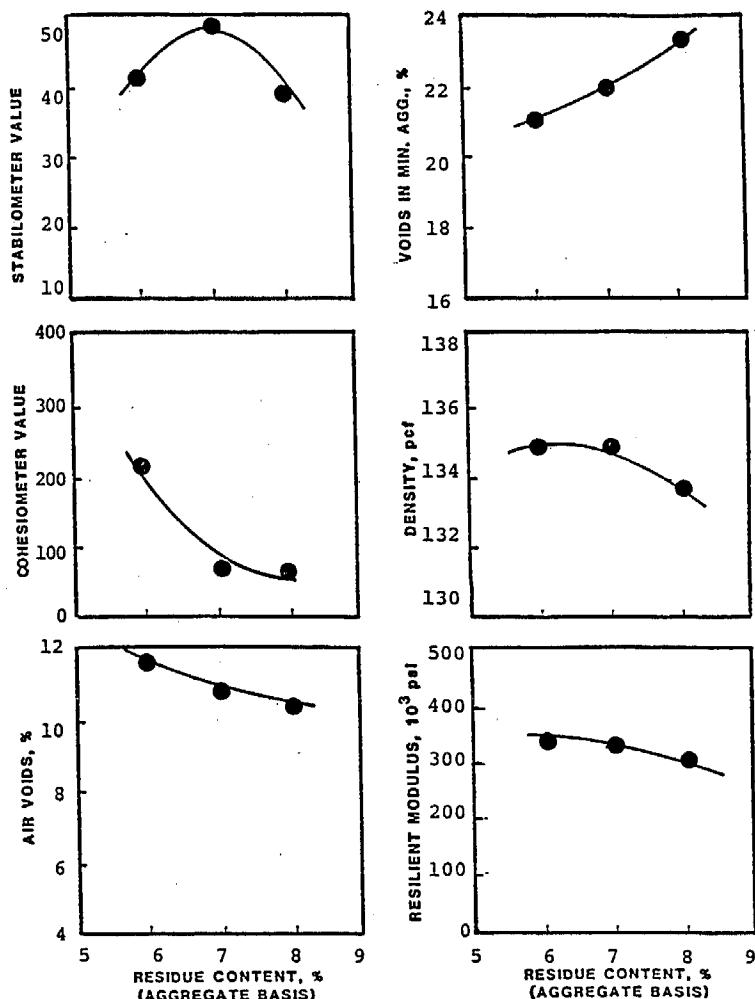


Figure B37. Mixture Design Data, San Bernardino,  
High Quality, SS-15% SEA, Replication 1

Table B38. Mixture Design Data, San Bernardino,  
High Quality, SS-15% SEA, Replication 2

Equivalent Residue Content, %	6.0	7.0	8.0	Design 7.0 %
Residue Content, %	6.30	7.35	8.40	Design 7.35 %
Bulk Specific Gravity	2.1710	2.1722	2.1714	-
Theoretical Specific Gravity	2.4298	2.3995	2.3705	-
Air Voids, %	10.7	9.5	8.4	9.5
V.M.A., %	20.5	21.3	22.1	21.3
Absorbed Asphalt, %	1.12	1.12	1.12	1.12
Effective Asphalt, %	4.88	5.88	6.88	5.88
Unit Weight, pcf	135.5	135.6	135.5	135.6
Stabilometer Value	39.5	39.8	31.8	39.8
Cohesimeter Value	110	62	70	62
Resilient Modulus, $10^3$ psi				
2-day	113	122	138	122
Final	290	271	282	271

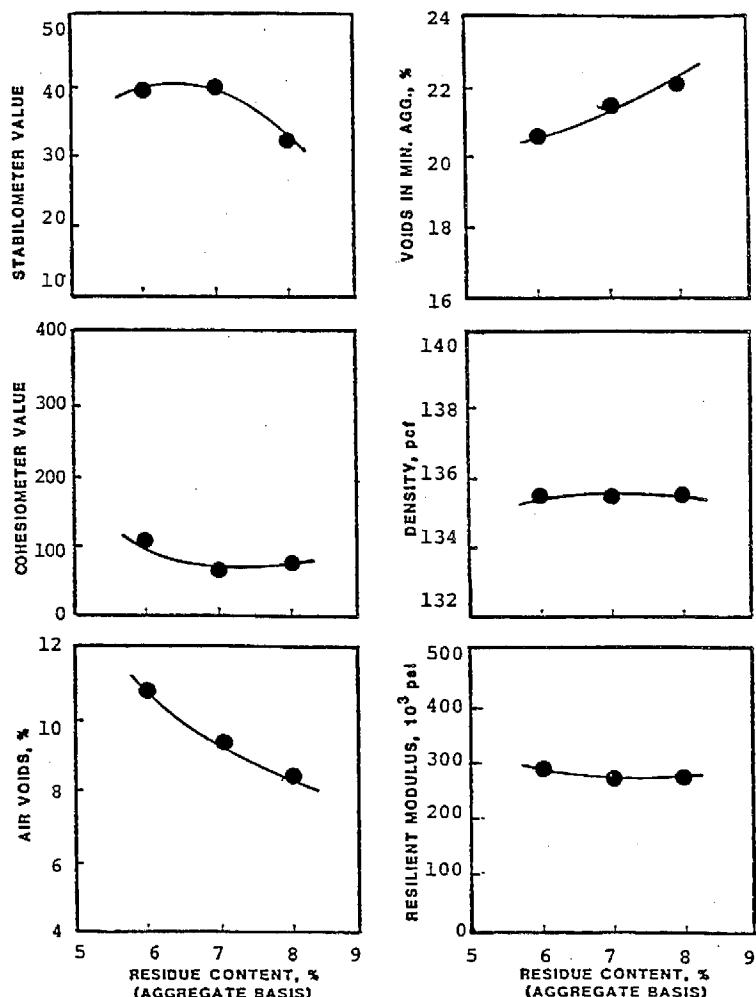


Figure B38. Mixture Design Data, San Bernardino,  
High Quality, SS-15% SEA, Replication 2

Table B39. Mixture Design Data, San Bernardino,  
High Quality, SS-30% SEA, Replication 1

Equivalent Residue Content, %	6.0	7.0	8.0	Design 7.0 %
Residue Content, %	6.90	8.05	9.20	Design 8.05 %
Bulk Specific Gravity	2.1790	2.1826	2.1910	-
Theoretical Specific Gravity	2.4255	2.3977	2.3710	-
Air Voids, %	10.2	9.0	7.6	9.0
V.M.A., %	20.7	21.4	21.9	21.4
Absorbed Asphalt, %	0.80	0.80	0.80	0.80
Effective Asphalt, %	6.10	7.10	8.10	7.10
Unit Weight, pcf	136.0	136.2	136.7	136.2
Stabilometer Value	43.7	40.0	28.9	40.0
Cohesimeter Value	219	229	202	229
Resilient Modulus, $10^3$ psi				
2-day	141	158	184	158
Final	333	282	273	282

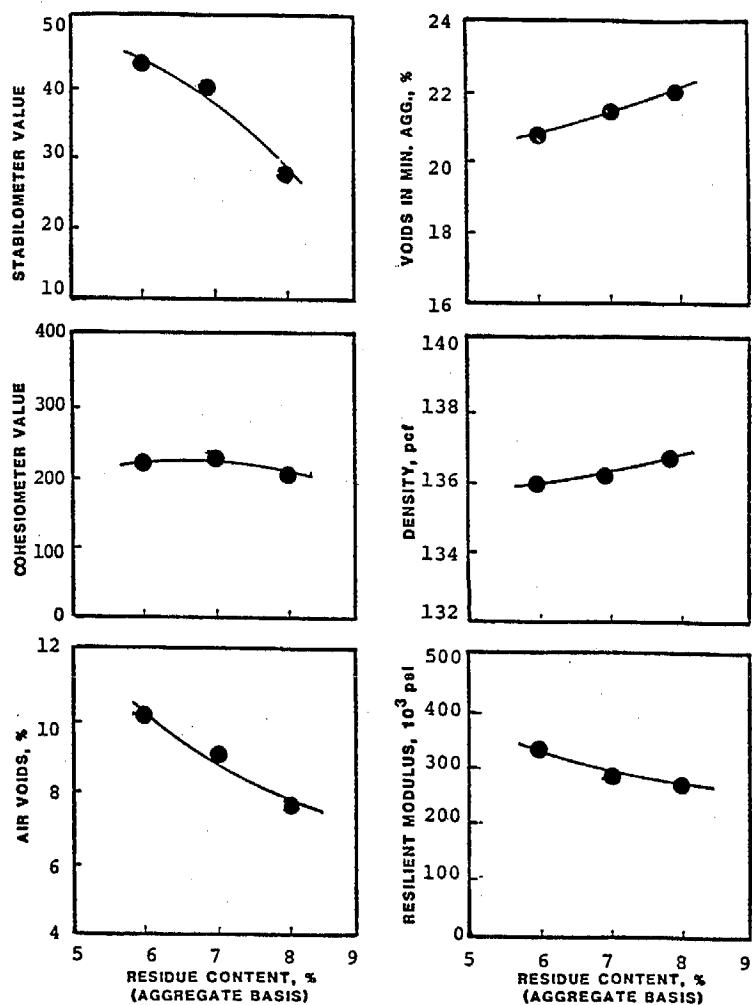


Figure B39. Mixture Design Data, San Bernardino,  
High Quality, SS-30% SEA, Replication 1

Table B40. Mixture Design Data, San Bernardino,  
High Quality, SS-30% SEA, Replication 2

Equivalent Residue Content, %	6.0	7.0	8.0	Design 7.0 %
Residue Content, %	6.90	8.05	9.20	Design 8.05 %
Bulk Specific Gravity	2.1986	2.1964	2.1948	-
Theoretical Specific Gravity	2.4499	2.4212	2.3938	-
Air Voids, %	10.3	9.3	8.3	9.3
V.M.A., %	20.0	20.9	21.8	20.9
Absorbed Asphalt, %	1.24	1.24	1.24	1.24
Effective Asphalt, %	4.76	5.76	6.76	5.76
Unit Weight, pcf	137.2	137.1	136.0	137.1
Stabilometer Value	42.2	40.3	26.5	40.3
Cohesimeter Value	270	306	160	306
Resilient Modulus, $10^3$ psi				
2-day	99	140	154	140
Final	298	310	254	310

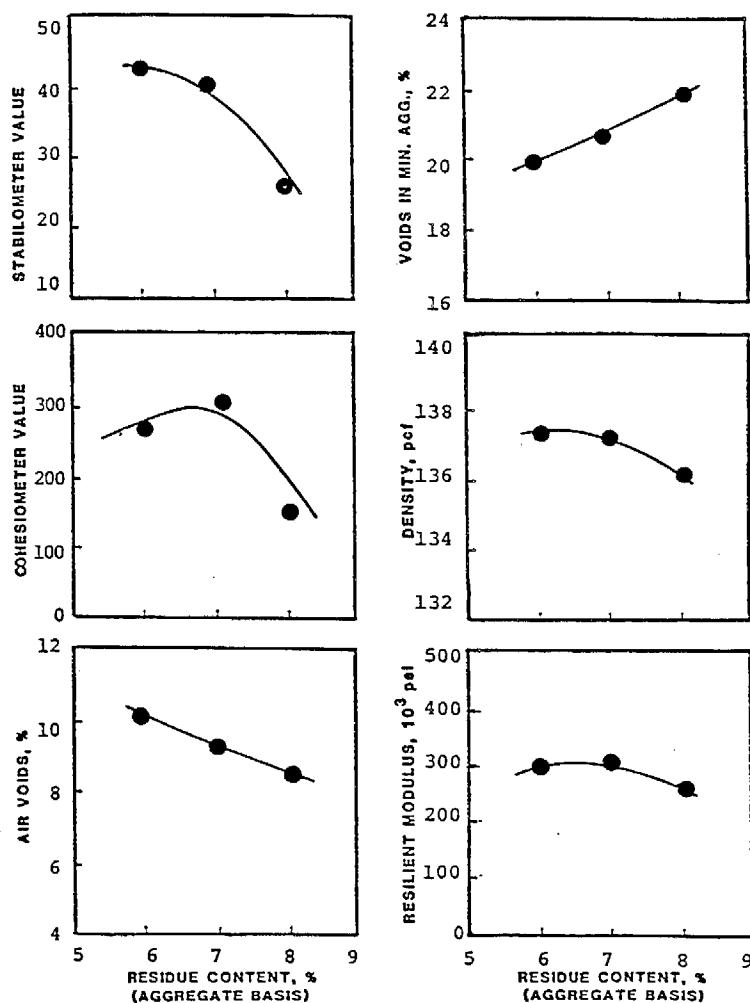


Figure B40. Mixture Design Data, San Bernardino,  
High Quality, SS-30% SEA, Replication 2

Table B41. Mixture Design Data, San Bernardino,  
Low Quality, SS-15% SEA, Replication 1

Equivalent Residue Content, %	6.5	7.5	8.5	Design 7.5 %
Residue Content, %	6.83	7.89	8.93	Design 7.89 %
Bulk Specific Gravity	2.1624	2.1445	2.1375	-
Theoretical Specific Gravity	2.4097	2.3802	2.3520	-
Air Voids, %	10.3	9.9	9.2	9.9
V.M.A., %	21.3	22.8	23.8	22.8
Absorbed Asphalt, %	1.00	1.00	1.00	1.00
Effective Asphalt, %	5.50	6.50	7.50	6.50
Unit Weight,pcf	134.9	133.8	133.4	133.8
Stabilometer Value	42.3	29.5	28.5	29.5
Cohesimeter Value	70	174	82	174
Resilient Modulus, $10^3$ psi				
2-day	150	139	138	139
Final	318	310	254	310

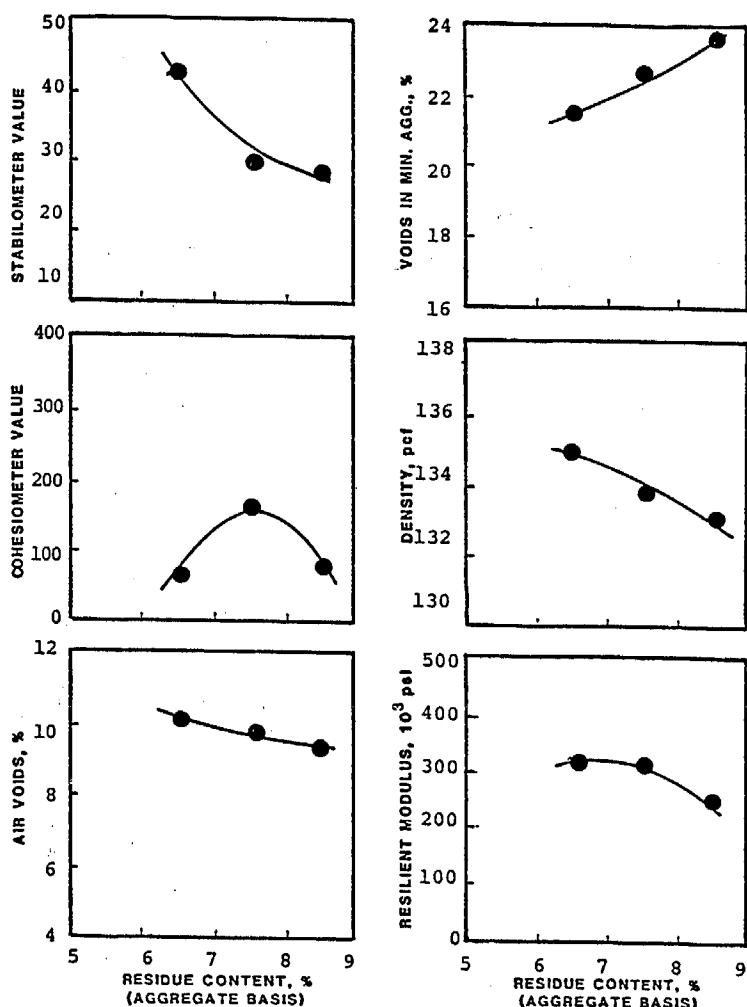


Figure B41. Mixture Design Data, San Bernardino,  
Low Quality, SS-15% SEA, Replication 1

Table B42. Mixture Design Data, San Bernardino,  
Low Quality, SS-15% SEA, Replication 2

Equivalent Residue Content, %	6.5	7.5	8.5	Design 7.5 %
Residue Content, %	6.83	7.88	8.93	Design 7.86 %
Bulk Specific Gravity	2.1424	2.1394	2.1455	-
Theoretical Specific Gravity	2.4147	2.3851	2.3567	-
Air Voids, %	11.3	10.3	9.0	10.3
V.M.A., %	22.1	22.9	23.4	22.9
Absorbed Asphalt, %	1.09	1.09	1.09	1.09
Effective Asphalt, %	5.41	6.41	7.41	6.41
Unit Weight, pcf	133.7	133.5	133.9	133.5
Stabilometer Value	41.2	32.8	28.0	32.8
Cohesimeter Value	129	103	81	103
Resilient Modulus, $10^3$ psi				
2-day	167	141	162	141
Final	325	260	280	260

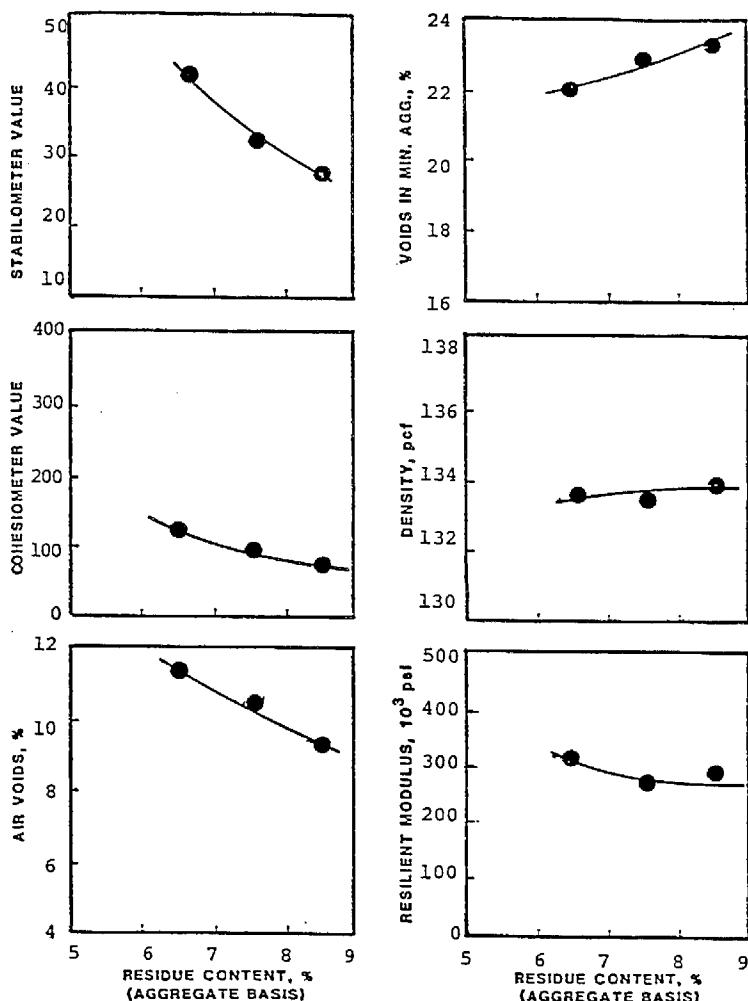


Figure B42. Mixture Design Data, San Bernardino,  
Low Quality, SS-15% SEA, Replication 2

Table B43. Mixture Design Data, San Bernardino,  
Low Quality, SS-30% SEA, Replication 1

Equivalent Residue Content, %	6.5	7.5	8.5	Design 7.5 %
Residue Content, %	7.48	8.63	9.78	Design 8.63 %
Bulk Specific Gravity	2.1752	2.1661	2.1638	-
Theoretical Specific Gravity	2.4136	2.3863	2.3602	-
Air Voids, %	9.9	9.2	8.3	9.2
V.M.A., %	21.3	22.5	23.4	22.5
Absorbed Asphalt, %	0.81	0.81	0.81	0.81
Effective Asphalt, %	5.69	6.69	7.69	6.69
Unit Weight, pcf	135.7	135.2	135.0	135.2
Stabilometer Value	46.6	36.7	23.5	36.7
Cohesimeter Value	224	266	138	266
Resilient Modulus, $10^3$ psi				
2-day	220	189	209	189
Final	478	337	281	337

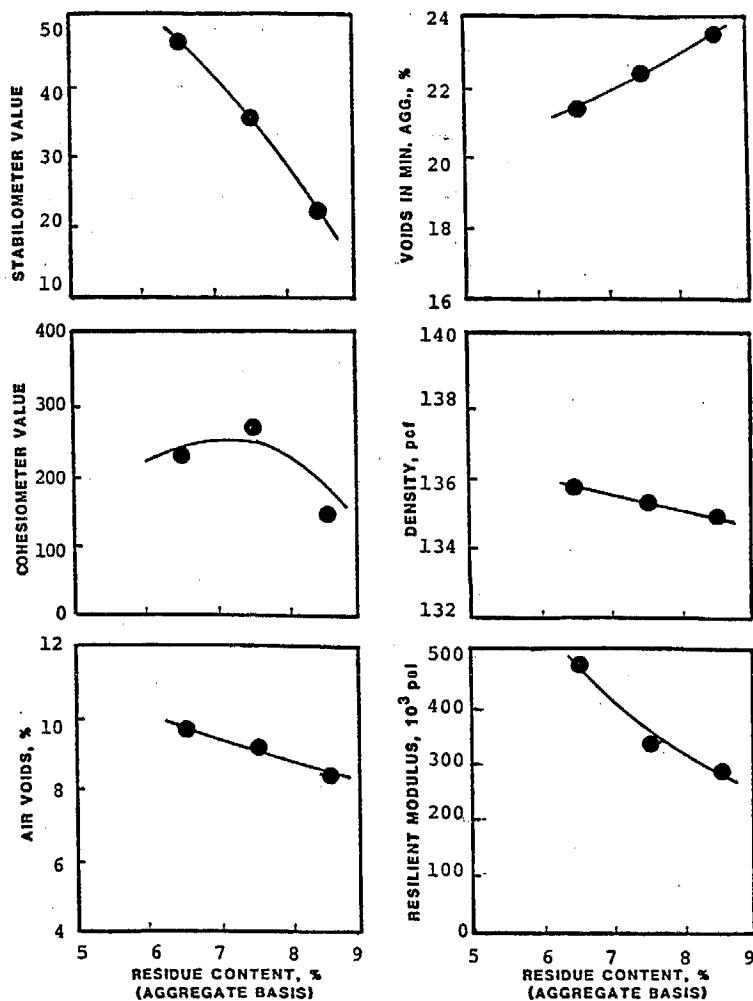


Figure B43. Mixture Design Data, San Bernardino,  
Low Quality, SS-30% SEA, Replication 1

Table B44. Mixture Design Data, San Bernardino,  
Low Quality, SS-30% SEA, Replication 2

Equivalent Residue Content, %	6.5	7.5	8.5	Design 7.5 %
Residue Content, %	7.48	8.63	9.78	Design 8.63 %
Bulk Specific Gravity	2.1676	2.1711	2.1641	-
Theoretical Specific Gravity	2.3998	2.3729	2.3472	-
Air Voids, %	9.7	8.5	7.8	8.5
V.M.A., %	20.8	22.3	23.4	22.3
Absorbed Asphalt, %	0.55	0.55	0.55	0.55
Effective Asphalt, %	5.95	6.95	7.95	6.95
Unit Weight, pcf	135.3	135.5	135.1	135.5
Stabilometer Value	40.9	28.3	22.7	28.3
Cohesimeter Value	248	187	186	187
Resilient Modulus, $10^3$ psi				
2-day	189	198	177	198
Final	308	255	285	255

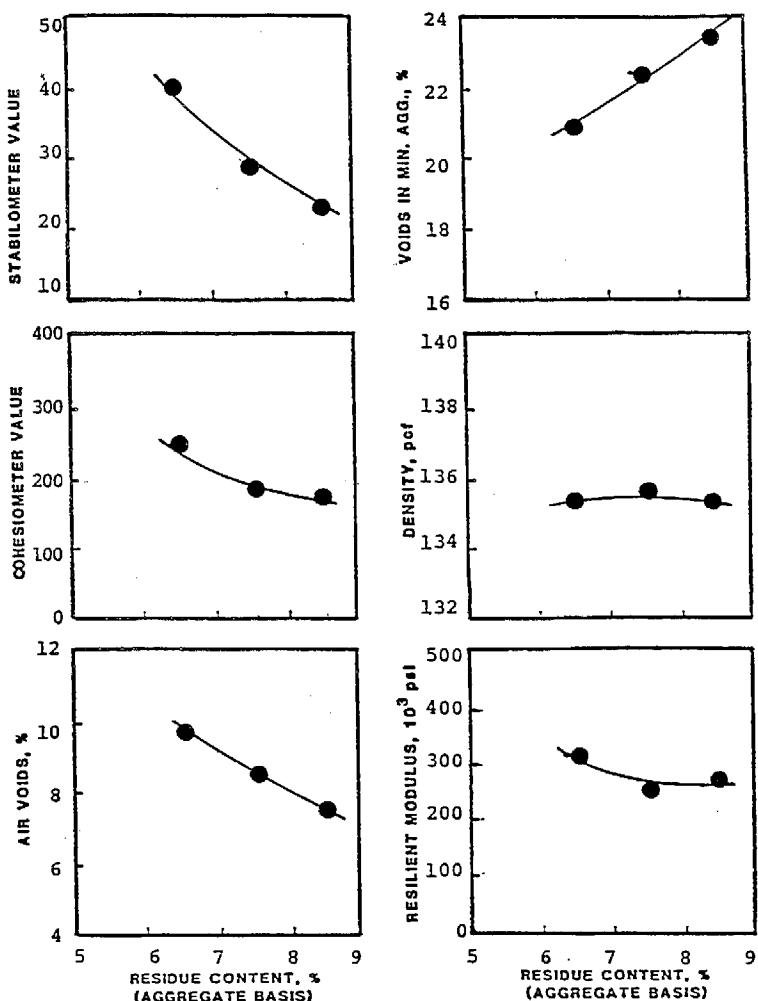


Figure B44. Mixture Design Data, San Bernardino,  
Low Quality, SS-30% SEA, Replication 2

Table B45. Mixture Design Data, Fresno,  
High Quality, SS-15% SEA, Replication 1

Equivalent Residue Content, %	6.0	7.0	8.0	Design 7.0 %
Residue Content, %	6.30	7.35	8.40	Design 7.35 %
Bulk Specific Gravity	2.1651	2.1581	2.1592	-
Theoretical Specific Gravity	2.4033	2.3739	2.3457	-
Air Voids, %	9.9	9.1	8.0	9.1
V.M.A., %	18.0	19.0	19.8	19.0
Absorbed Asphalt, %	3.99	4.99	5.99	4.99
Effective Asphalt, %	135.1	134.7	134.7	134.7
Unit Weight, pcf	30.9	43.9	35.8	43.9
Stabilometer Value	150	236	202	236
Cohesiometer Value				
Resilient Modulus, $10^3$ psi	140	171	148	171
2-day	294	390	367	390
Final				

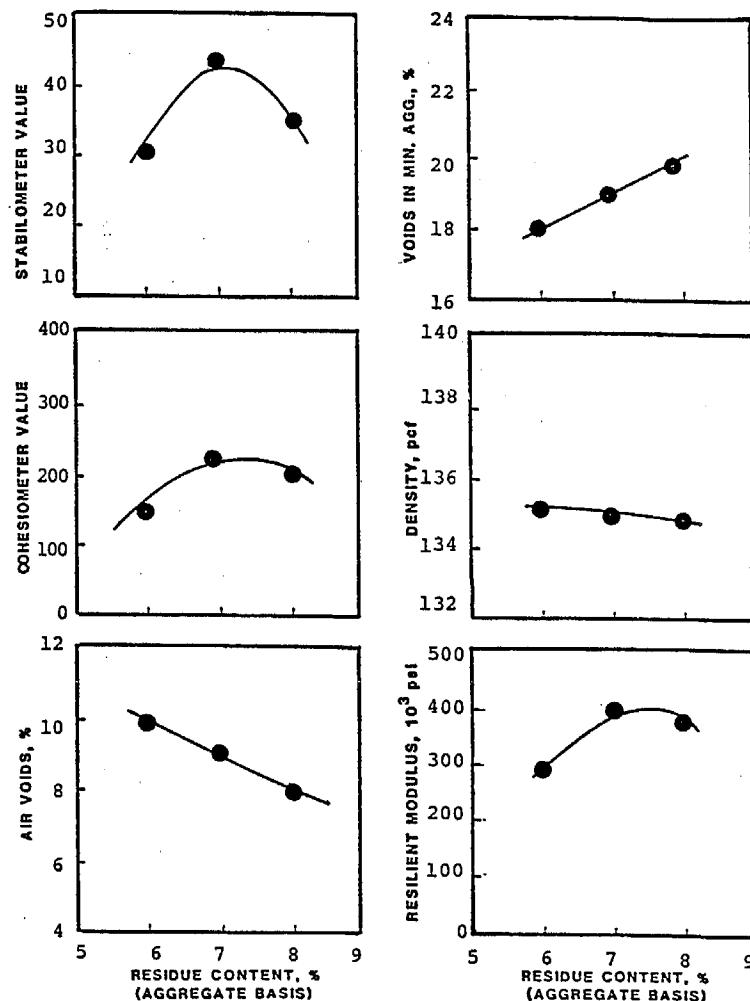


Figure B45. Mixture Design Data, Fresno,  
High Quality, SS-15% SEA, Replication 1

Table B46. Mixture Design Data, Fresno,  
High Quality, SS-15% SEA, Replication 2

	6.0	7.0	8.0	Design 7.0 %
Residue Content, %	6.30	7.35	8.40	Design 7.35 %
Bulk Specific Gravity	2.1413	2.1627	2.1711	-
Theoretical Specific Gravity	2.4321	2.4017	2.3726	-
Air Voids, %	12.0	9.9	8.5	9.9
V.M.A., %	18.9	18.9	19.3	18.9
Absorbed Asphalt, %	2.49	2.49	2.49	2.49
Effective Asphalt, %	3.51	4.51	5.51	4.51
Unit Weight, pcf	133.6	135.0	135.5	135.0
Stabilometer Value	40.7	39.6	36.0	39.6
Cohesiometer Value	79	76	64	76
Resilient Modulus, $10^3$ psi				
2-day	147	165	175	165
Final	361	340	305	340

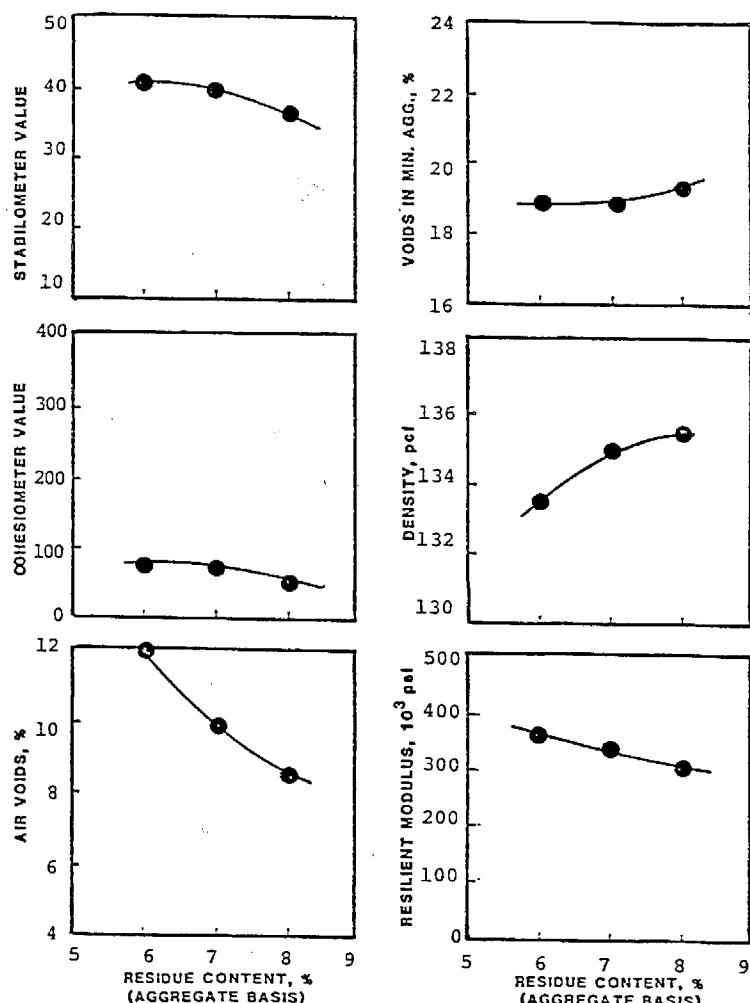


Figure B46. Mixture Design Data, Fresno,  
High Quality, SS-15% SEA, Replication 2

Table B47. Mixture Design Data, Fresno,  
High Quality, SS-30% SEA, Replication 1

Equivalent Residue Content, %	6.0	7.0	8.0	Design 7.0 %
Residue Content, %	6.90	8.05	9.20	Design 8.05 %
Bulk Specific Gravity	2.1880	2.1958	2.2006	-
Theoretical Specific Gravity	2.4453	2.4182	2.3909	-
Air Voids, %	10.5	9.2	8.8	9.2
V.M.A., %	17.6	18.1	18.8	18.1
Absorbed Asphalt, %	2.56	2.56	2.56	2.56
Effective Asphalt, %	3.44	4.44	5.44	4.44
Unit Weight, pcf	136.5	137.0	137.3	137.0
Stabilometer Value	44.3	34.2	29.1	34.2
Cohesimeter Value	58	78	73	78
Resilient Modulus, $10^3$ psi				
2-day	174	184	167	184
Final	381	303	298	303

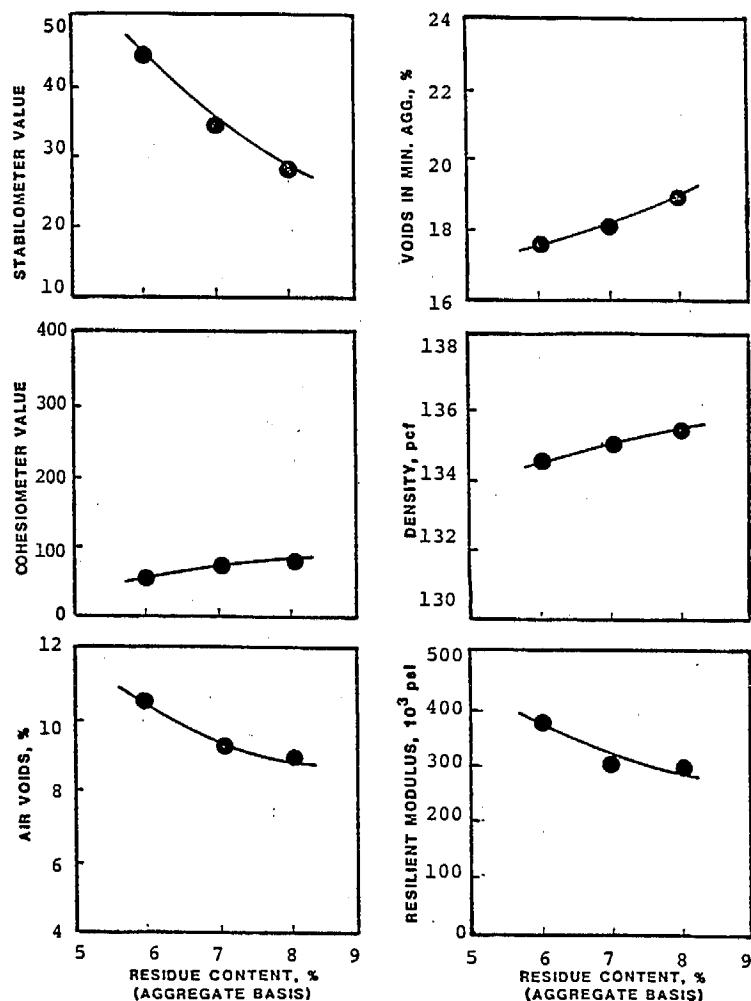


Figure B47. Mixture Design Data, Fresno,  
High Quality, SS-30% SEA, Replication 1

Table B48. Mixture Design Data, Fresno,  
High Quality, SS-30% SEA, Replication 2

Equivalent Residue Content, %	6.0	7.0	8.0	Design 7.0 %
Residue Content, %	6.90	8.05	9.20	Design 8.05 %
Bulk Specific Gravity	2.1816	2.1806	2.1996	-
Theoretical Specific Gravity	2.4403	2.4120	2.3849	-
Air Voids, %	10.6	9.6	7.8	9.6
V.M.A., %	17.8	18.7	18.9	18.7
Absorbed Asphalt, %	2.44	2.44	2.44	2.44
Effective Asphalt, %	3.56	4.56	5.56	4.56
Unit Weight, pcf	136.1	136.1	137.3	136.1
Stabilometer Value	48.2	41.1	31.4	41.1
Cohesimeter Value	136	130	106	130
Resilient Modulus, $10^3$ psi				
2-day	183	187	260	187
Final	393	374	361	374

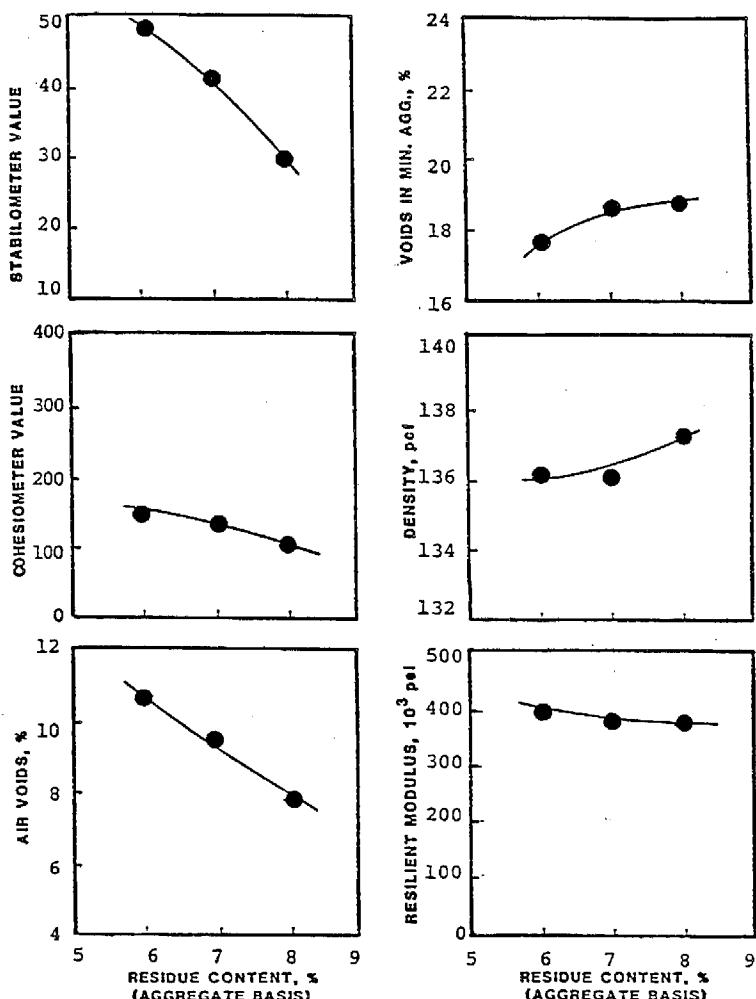


Figure B48. Mixture Design Data, Fresno,  
High Quality, SS-30% SEA, Replication 2

Table B49. Mixture Design Data, Fresno,  
Low Quality, SS-15% SEA, Replication 1

Equivalent Residue Content, %	6.5	7.5	8.5	Design 7.5 %
Residue Content, %	<u>6.83</u>	<u>7.88</u>	<u>8.93</u>	Design 7.88 %
Bulk Specific Gravity	2.1404	2.1439	2.1381	-
Theoretical Specific Gravity	2.3563	2.3286	2.3020	-
Air Voids, %	9.2	7.9	7.1	7.9
V.M.A., %	19.3	19.9	20.9	19.9
Absorbed Asphalt, %	1.40	1.40	1.40	1.40
Effective Asphalt, %	5.10	6.10	7.10	6.10
Unit Weight, pcf	133.6	133.8	133.4	133.8
Stabilometer Value	42.4	39.7	30.8	39.7
Cohesimeter Value	79	308	266	308
Resilient Modulus, $10^3$ psi				
2-day	173	185	196	185
Final	330	319	285	319

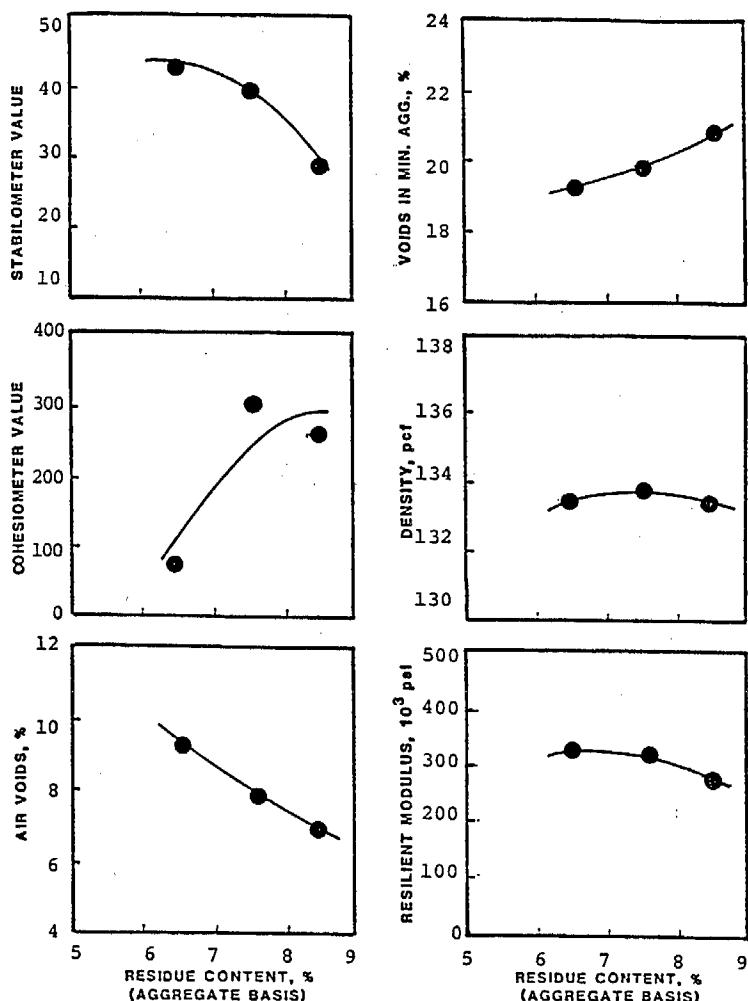


Figure B49. Mixture Design Data, Fresno,  
Low Quality, SS-15% SEA, Replication 1

Table B50. Mixture Design Data, Fresno,  
Low Quality, SS-15% SEA, Replication 2

Equivalent Residue Content, %	6.5	7.5	8.5	Design 7.5 %
Residue Content, %	6.83	7.88	8.93	Design 7.88 %
Bulk Specific Gravity	2.1527	2.1362	2.1337	-
Theoretical Specific Gravity	2.4013	2.3721	2.3441	-
Air Voids, %	10.4	9.9	9.0	9.9
V.M.A., %	18.8	20.2	21.1	20.2
Absorbed Asphalt, %	2.25	2.25	2.25	2.25
Effective Asphalt, %	4.25	5.25	6.25	5.25
Unit Weight,pcf	134.3	133.3	133.2	133.3
Stabilometer Value	41.0	41.8	29.0	41.8
Cohesiometer Value	261	62	100	62
Resilient Modulus, $10^3$ psi				
2-day	188	197	211	197
Final	334	348	331	348

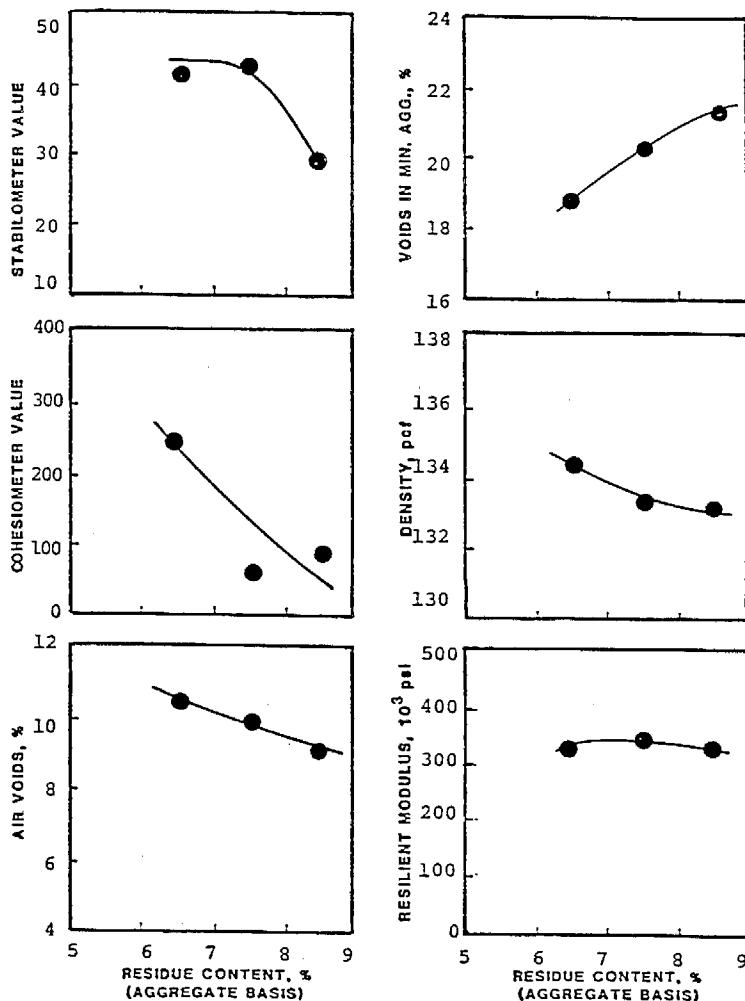


Figure B50. Mixture Design Data, Fresno,  
Low Quality, SS-15% SEA, Replication 2

Table B51. Mixture Design Data, Fresno,  
Low Quality, SS-30% SEA, Replication 1

Equivalent Residue Content, %	6.5	7.5	8.5	Design 7.5 %
Residue Content, %	7.48	8.63	9.78	Design 8.63 %
Bulk Specific Gravity	2.1728	2.1716	2.1673	-
Theoretical Specific Gravity	2.4022	2.3753	2.3495	-
Air Voids, %	9.6	8.6	7.8	8.6
V.M.A., %	18.6	19.5	20.5	19.5
Absorbed Asphalt, %	2.00	2.00	2.00	2.00
Effective Asphalt, %	4.50	5.50	6.50	5.50
Unit Weight, pcf	135.6	135.5	135.3	135.5
Stabilometer Value	43.6	39.2	37.8	39.2
Cohesimeter Value	100	260	201	260
Resilient Modulus, $10^3$ psi				
2-day	199	212	230	212
Final	376	362	337	362

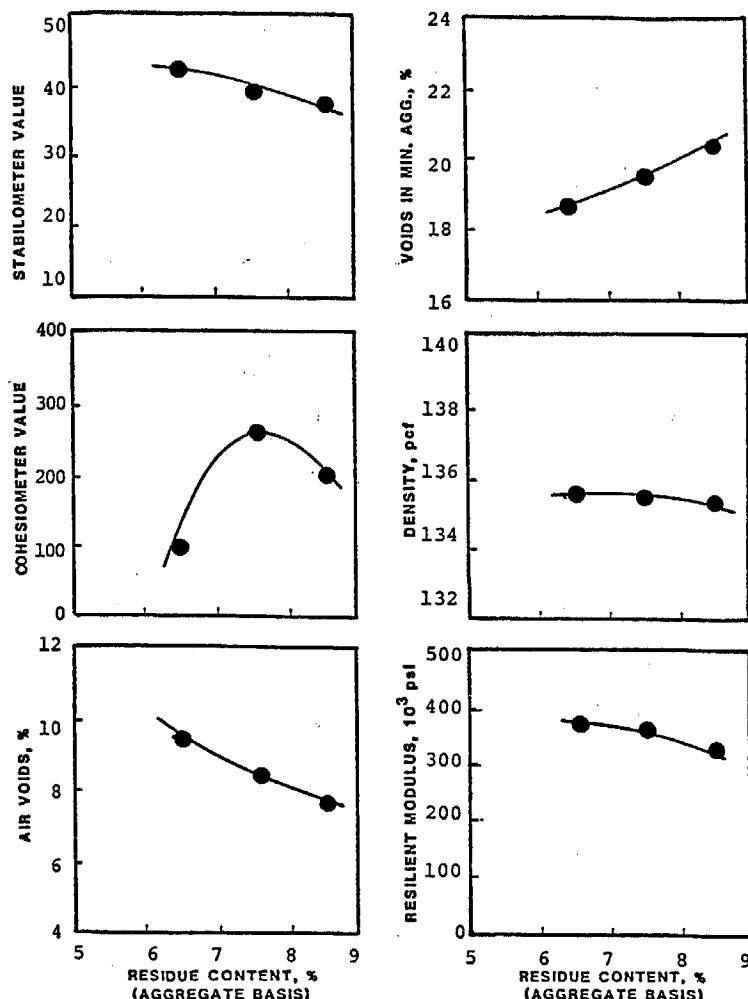


Figure B51. Mixture Design Data, Fresno,  
Low Quality, SS-30% SEA, Replication 1

Table B52. Mixture Design Data, Fresno,  
Low Quality, SS-30% SEA, Replication 2

Equivalent Residue Content, %	6.5	7.5	8.5	Design 7.5 %
Residue Content, %	7.48	8.63	9.78	Design 8.63 %
Bulk Specific Gravity	2.1595	2.1708	2.1637	-
Theoretical Specific Gravity	2.3977	2.3708	2.3452	-
Air Voids, %	9.9	8.4	7.7	8.4
V.M.A., %	19.1	19.5	20.6	19.5
Absorbed Asphalt, %	1.92	1.92	1.92	1.92
Effective Asphalt, %	4.58	5.58	6.58	5.58
Unit Weight,pcf	134.7	135.4	135.0	135.4
Stabilometer Value	50.2	26.2	23.9	26.2
Cohesimeter Value	257	136	154	136
Resilient Modulus, $10^3$ psi				
2-day	217	201	228	201
Final	371	307	290	307

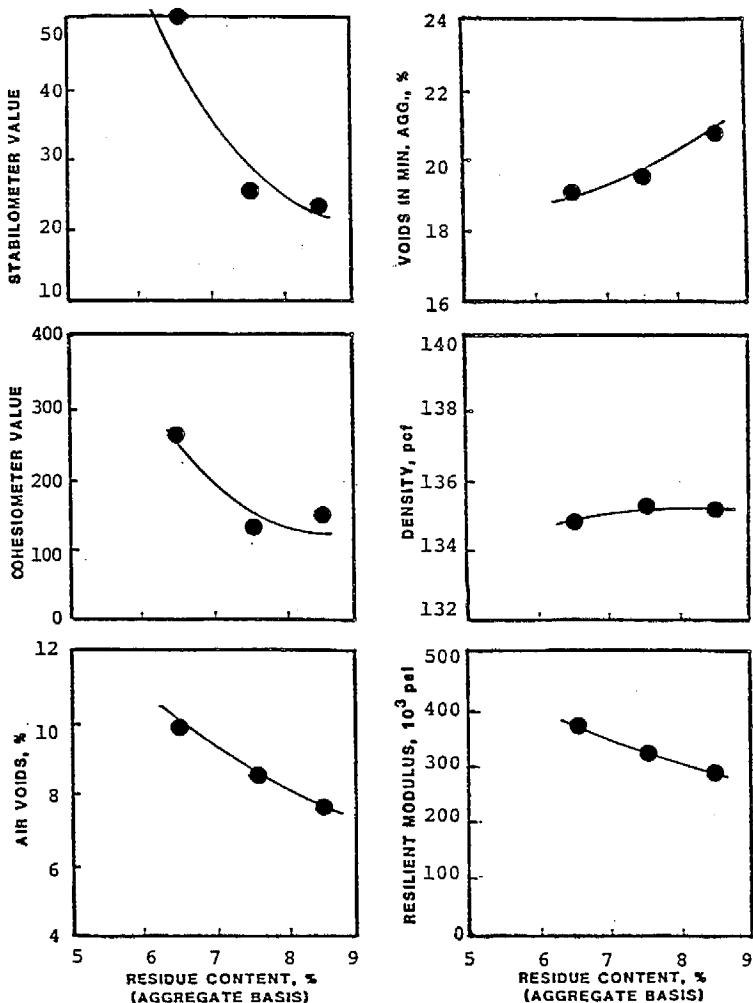


Figure B52. Mixture Design Data, Fresno,  
Low Quality, SS-30% SEA, Replication 2

Table B53. Mixture Design Data, Graniterock,  
High Quality, SS-15% SEA, Replication 1

Equivalent Residue Content, %	4.5	5.5	6.5	Design 5.5 %
Residue Content, %	4.73	5.78	6.83	Design 5.78 %
Bulk Specific Gravity	2.4210	2.4403	2.4473	-
Theoretical Specific Gravity	2.6934	2.6528	2.6142	-
Air Voids, %	10.1	8.0	6.4	8.0
V.M.A., %	19.9	20.1	20.6	20.1
Absorbed Asphalt, %	0.22	0.22	0.22	0.22
Effective Asphalt, %	4.23	5.23	6.23	5.23
Unit Weight, pcf	151.1	152.3	152.7	152.3
Stabilometer Value	30.8	28.8	19.7	28.8
Cohesimeter Value	117	112	140	112
Resilient Modulus, $10^3$ psi				
2-day	95	110	122	110
Final	306	272	214	272

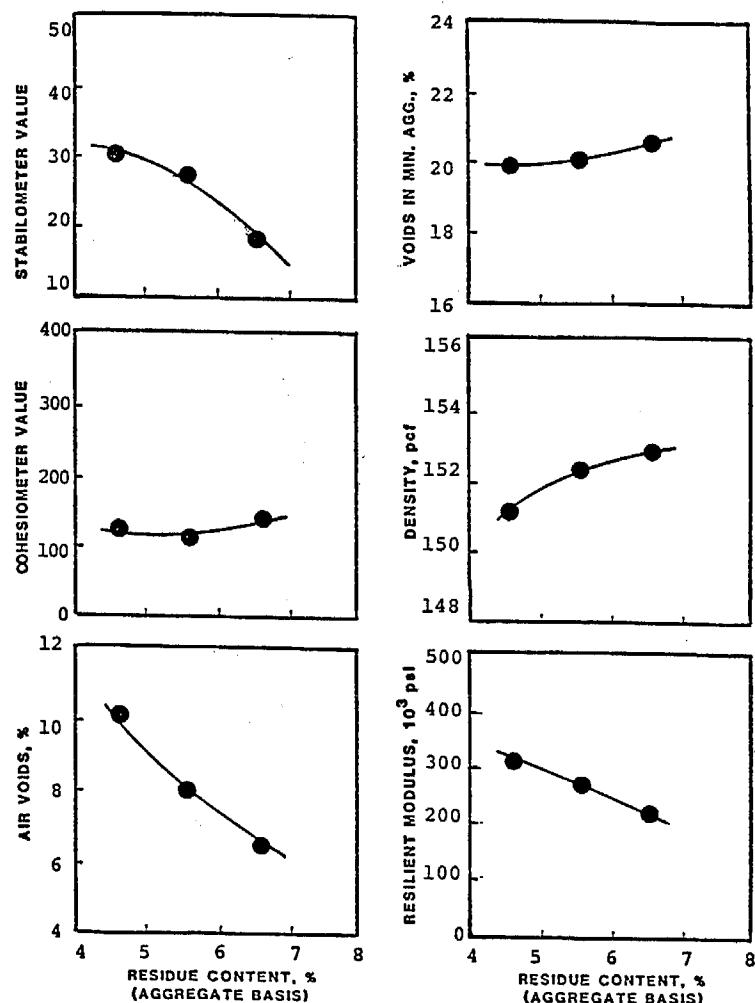


Figure B53. Mixture Design Data, Graniterock,  
High Quality, SS-15% SEA, Replication 1

Table B54. Mixture Design Data, Graniterock,  
High Quality, SS-15% SEA, Replication 2

Equivalent Residue Content, %	4.5	5.5	6.5	Design 5.5 %
Residue Content, %	4.73	5.78	6.83	Design 5.78 %
Bulk Specific Gravity	2.4197	2.4253	2.4435	-
Theoretical Specific Gravity	2.6843	2.6441	2.6058	-
Air Voids, %	9.9	8.3	6.2	8.3
V.M.A., %	19.9	20.6	20.8	20.6
Absorbed Asphalt, %	.09	.09	.09	.09
Effective Asphalt, %	4.41	5.41	6.41	5.41
Unit Weight, pcf	151.0	151.3	152.5	151.3
Stabilometer Value	38.1	30.7	20.4	30.7
Cohesiometer Value	73	85	149	85
Resilient Modulus, $10^3$ psi				
2-day	170	159	142	159
Final	333	367	193	367

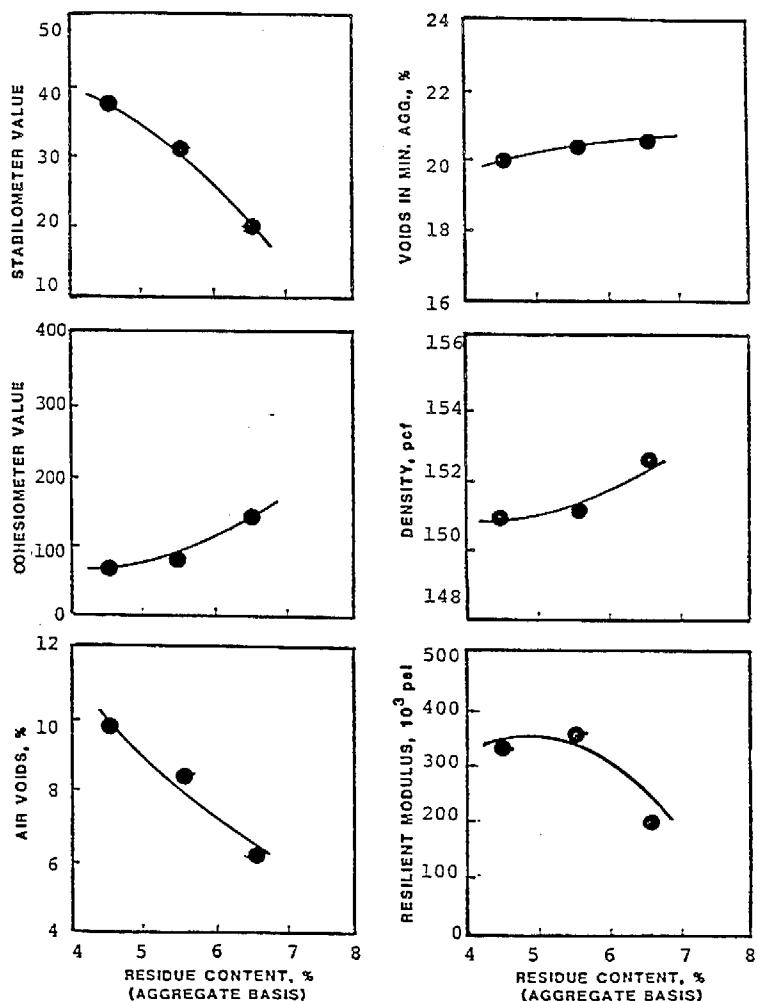


Figure B54. Mixture Design Data, Graniterock,  
High Quality, SS-15% SEA, Replication 2

Table B55. Mixture Design Data, Graniterock,  
High Quality, SS-30% SEA, Replication 1

Equivalent Residue Content, %	4.5	5.5	6.5	Design 5.5 %
Residue Content, %	5.18	6.33	7.48	Design 6.33 %
Bulk Specific Gravity	2.4695	2.4765	2.4666	-
Theoretical Specific Gravity	2.6898	2.6520	2.6160	-
Air Voids, %	8.2	6.6	5.7	6.6
V.M.A., %	18.7	19.3	20.5	19.3
Absorbed Asphalt, %	0.01	0.01	0.01	0.01
Effective Asphalt, %	4.49	5.49	6.49	5.49
Unit Weight, pcf	154.1	154.5	153.9	154.5
Stabilometer Value	41.1	31.0	24.1	31.0
Cohesimeter Value	159	157	165	157
Resilient Modulus, $10^3$ psi				
2-day	183	178	193	178
Final	371	318	250	318

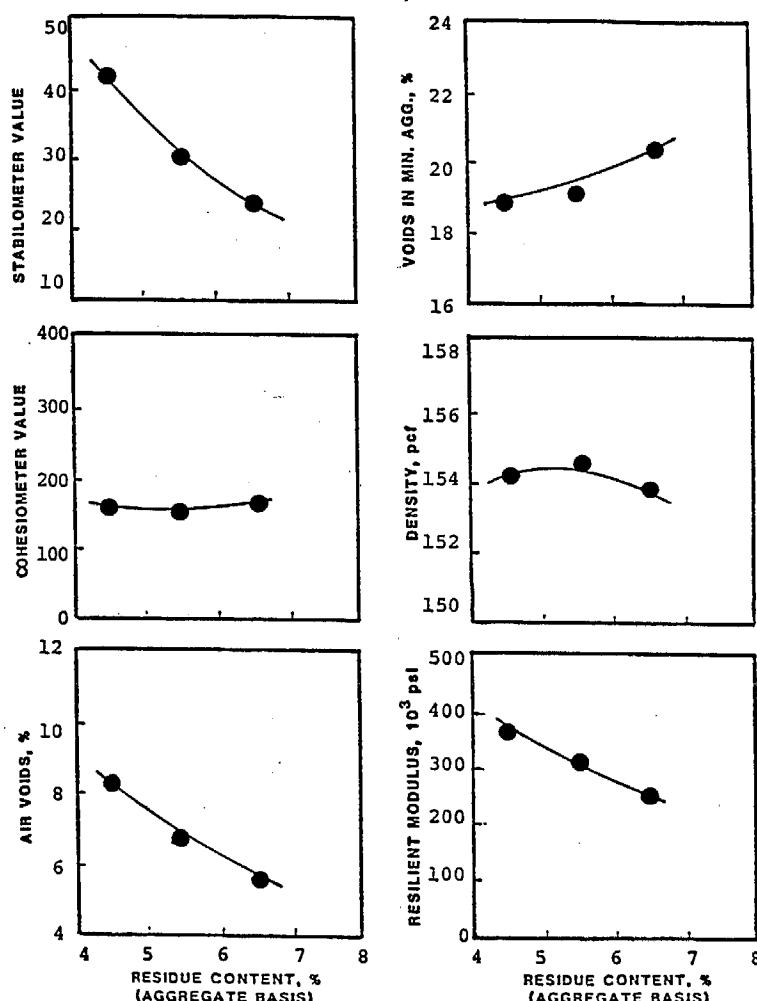


Figure B55. Mixture Design Data, Graniterock,  
High Quality, SS-30% SEA, Replication 1

Table B56. Mixture Design Data, Graniterock,  
High Quality, SS-30% SEA, Replication 2

Equivalent Residue Content, %	4.5	5.5	6.5	Design 5.5 %
Residue Content, %	5.18	6.33	7.48	Design 6.33 %
Bulk Specific Gravity	2.4594	2.4844	2.4856	-
Theoretical Specific Gravity	2.7024	2.6641	2.6276	-
Air Voids, %	9.0	6.7	5.4	6.7
V.M.A., %	19.0	19.0	19.9	19.0
Absorbed Asphalt, %	0.19	0.19	0.19	0.19
Effective Asphalt, %	4.31	5.31	6.31	5.31
Unit Weight,pcf	153.5	155.0	155.1	155.0
Stabilometer Value	45.0	32.4	23.4	32.4
Cohesiometer Value	198	212	225	212
Resilient Modulus, $10^3$ psi				
2-day	191	173	166	173
Final	360	308	259	308

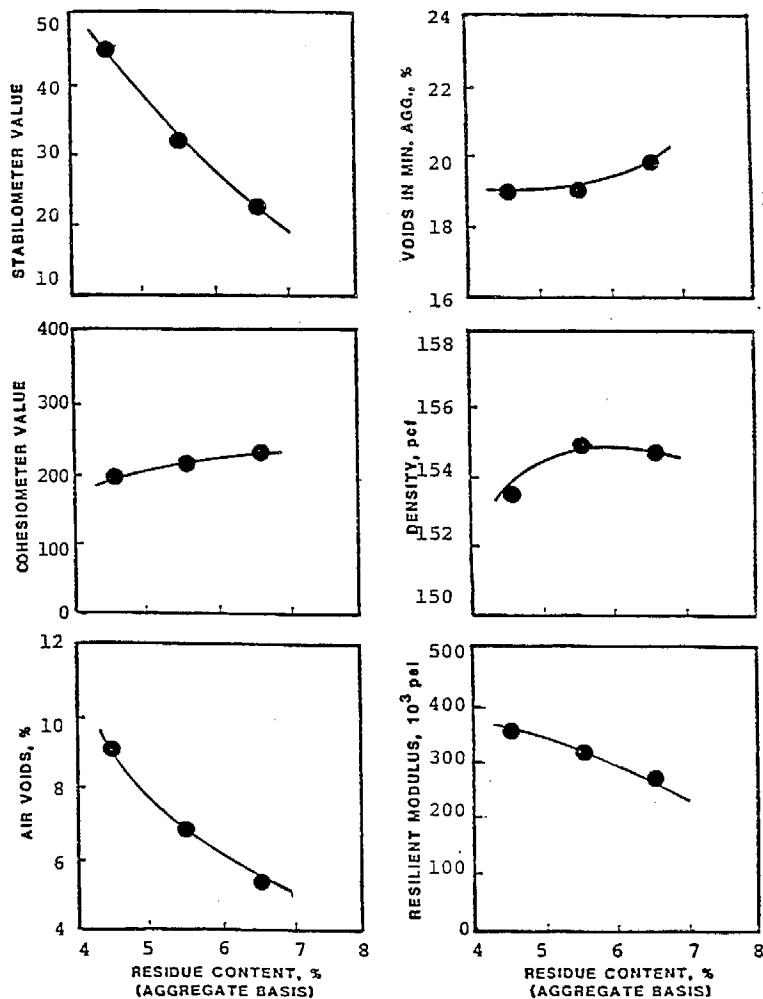


Figure B56. Mixture Design Data, Graniterock,  
High Quality, SS-30% SEA, Replication 2

Table B57. Mixture Design Data, Graniterock,  
Low Quality, SS-15% SEA, Replication 1

Equivalent Residue Content, %	5.0	6.0	7.0	Design 6.0 %
Residue Content, %	5.30	6.36	7.42	Design 6.36 %
Bulk Specific Gravity	2.4024	2.4040	2.3986	-
Theoretical Specific Gravity	2.6676	2.6279	2.5901	-
Air Voids, %	9.9	8.5	7.4	8.5
V.M.A., %	20.7	21.4	22.3	21.4
Absorbed Asphalt, %	0.31	0.31	0.31	0.31
Effective Asphalt, %	4.69	5.69	6.69	5.69
Unit Weight, pcf	149.9	150.0	149.7	150.0
Stabilometer Value	35.4	22.3	14.9	22.3
Cohesimeter Value	138	222	126	222
Resilient Modulus, $10^3$ psi				
2-day	183	159	160	159
Final	352	302	234	302

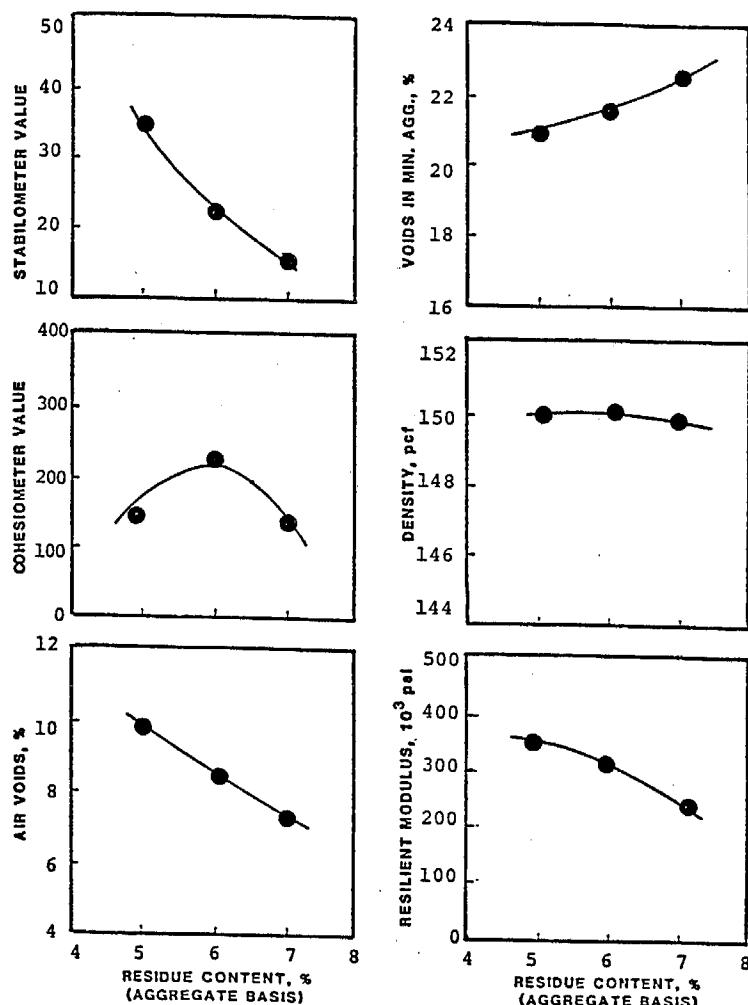


Figure B57. Mixture Design Data, Graniterock,  
Low Quality, SS-15% SEA, Replication 1

Table B58. Mixture Design Data, Graniterock,  
Low Quality, SS-15% SEA, Replication 2

	Equivalent Residue Content, %	6.0	6.0	7.0	Design 6.0 %
	Residue Content, %	5.25	6.30	7.35	Design 6.30 %
Bulk Specific Gravity		2.3944	2.3988	2.3793	-
Theoretical Specific Gravity		2.6592	2.6022	2.5830	-
Air Voids, %		10.0	8.4	7.9	8.4
V.M.A., %		20.9	21.5	22.9	21.5
Absorbed Asphalt, %		0.15	0.15	0.15	
Effective Asphalt, %		4.85	5.85	6.85	5.85
Unit Weight, pcf		149.4	149.7	148.5	149.7
Stabilometer Value		37.7	30.7	21.7	30.7
Cohesimeter Value		151	180	170	180
Resilient Modulus, $10^3$ psi					
2-day		162	165	169	165
Final		375	356	277	356

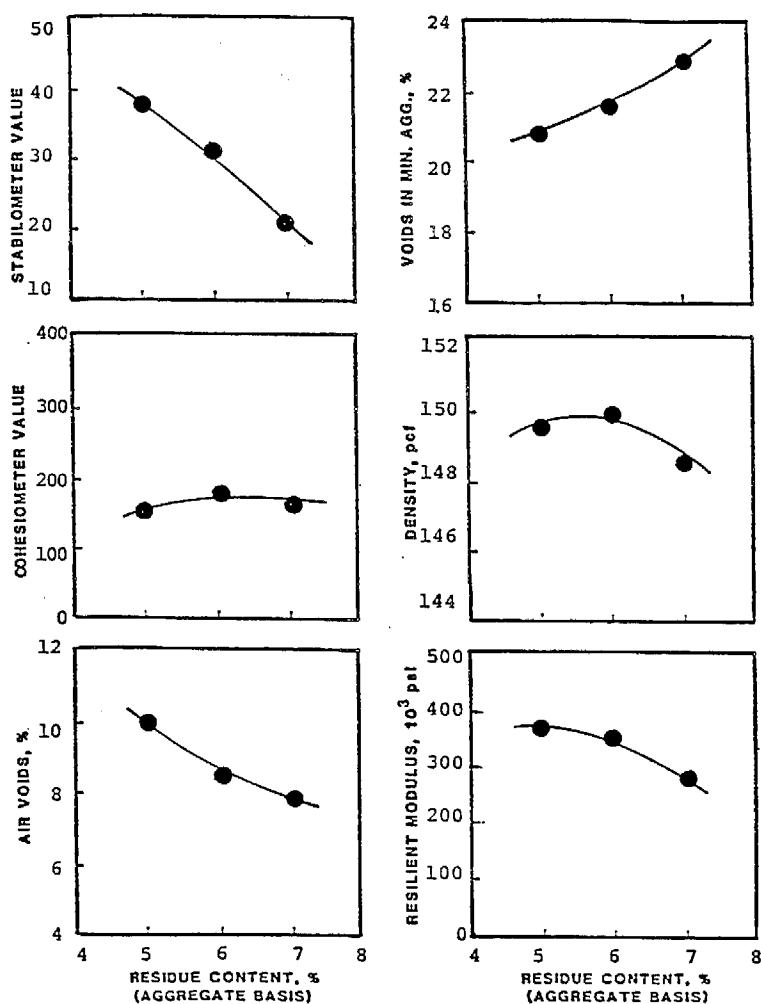


Figure B58. Mixture Design Data, Graniterock,  
Low Quality, SS-15% SEA, Replication 2

Table B59. Mixture Design Data, Graniterock,  
Low Quality, SS-30% SEA, Replication 1

Equivalent Residue Content, %	5.0	6.0	7.0	Design 6.0 %
Residue Content, %	5.75	6.90	8.05	Design 6.90 %
Bulk Specific Gravity	2.4389	2.4362	2.4419	-
Theoretical Specific Gravity	2.6670	2.6303	2.5953	-
Air Voids, %	8.6	7.4	5.9	7.4
V.M.A., %	19.8	20.7	21.4	20.7
Absorbed Asphalt, %	0.09	0.09	0.09	0.09
Effective Asphalt, %	4.91	5.91	6.91	5.91
Unit Weight,pcf	152.2	152.0	152.4	152.0
Stabilometer Value	38.1	29.2	22.0	29.2
Cohesimeter Value	263	186	176	186
Resilient Modulus, $10^3$ psi				
2-day	222	222	207	222
Final	380	289	293	289

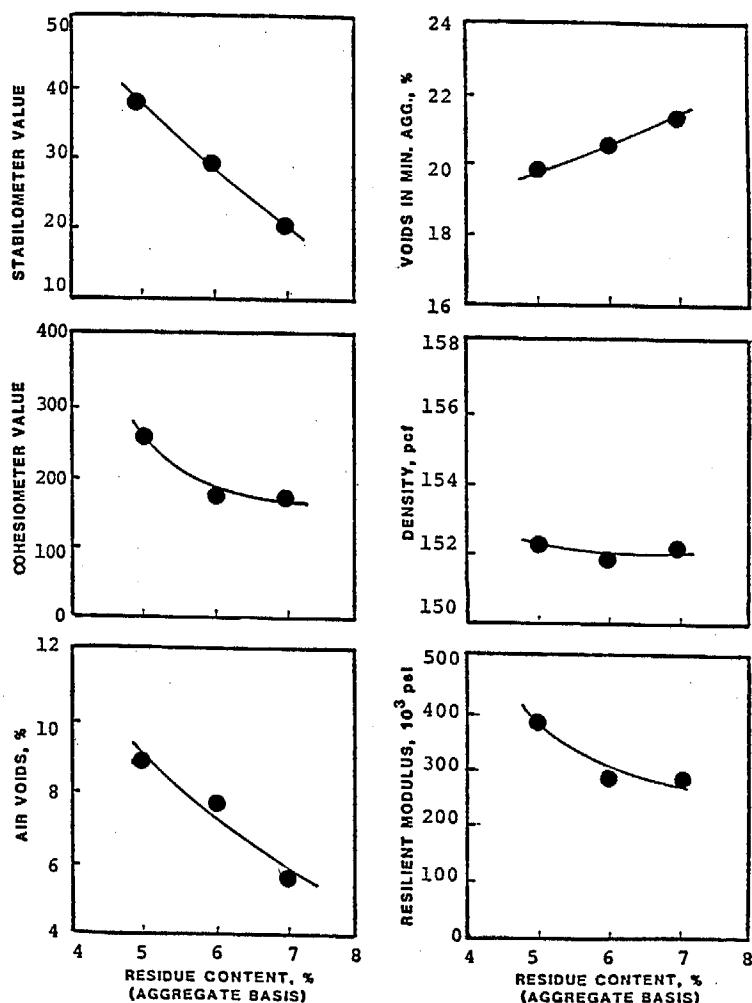


Figure B59. Mixture Design Data, Graniterock,  
Low Quality, SS-30% SEA, Replication 1

Table B60. Mixture Design Data, Graniterock,  
Low Quality, SS-30% SEA, Replication 2

Equivalent Residue Content, %	5.0	6.0	7.0	Design 6.0 %
Residue Content, %	5.75	6.90	8.05	Design 6.90 %
Bulk Specific Gravity	2.4371	2.4441	2.4445	-
Theoretical Specific Gravity	2.6744	2.6373	2.6020	-
Air Voids, %	8.9	7.3	6.1	7.3
V.M.A., %	19.9	20.5	21.3	20.5
Absorbed Asphalt, %	0.19	0.19	0.19	0.19
Effective Asphalt, %	4.81	5.81	6.81	5.81
Unit Weight, pcf	152.1	152.5	152.5	152.5
Stabilometer Value	33.5	23.6	19.1	23.6
Cohesimeter Value	220	164	180	164
Resilient Modulus, $10^3$ psi				
2-day	194	199	191	199
Final	388	329	294	329

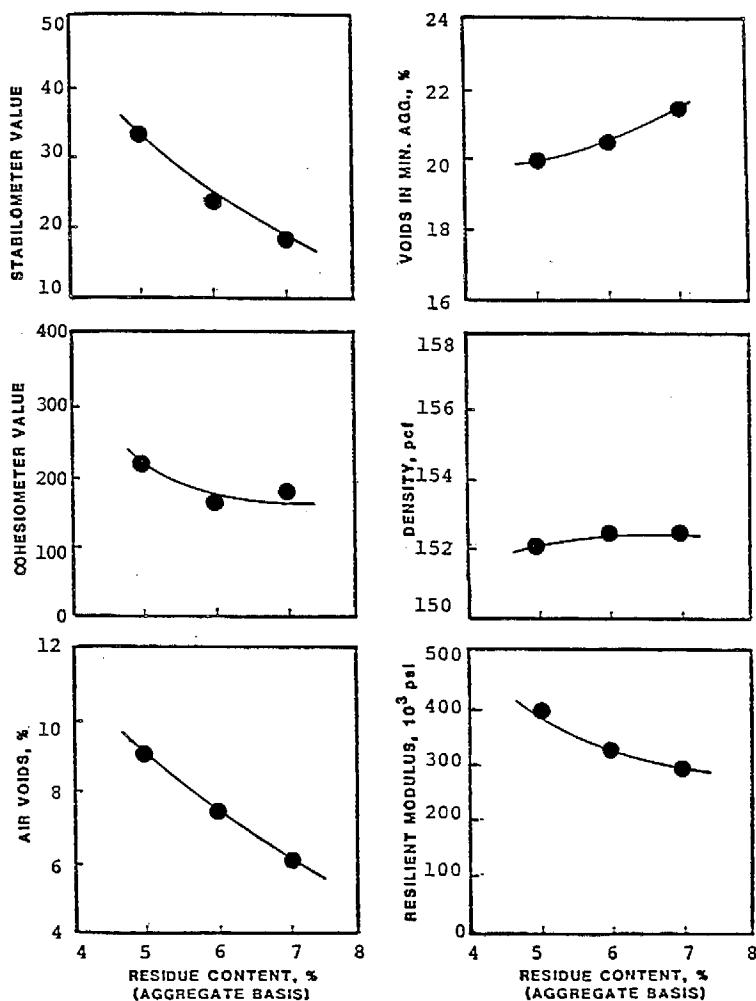


Figure B60. Mixture Design Data, Graniterock,  
Low Quality, SS-30% SEA, Replication 2

## **APPENDIX C**

**DATA ANALYSIS, SOLVENT FREE AND  
CONVENTIONAL EMULSIONS**

Table Cl. Aggregate Coating at Design Residue Content, %

		EMULSION			
		QUALITY LEVEL			
		AGGREGATE			
		SAN BERNARDINO		FRESNO	
		HIGH	LOW	HIGH	LOW
C S S O	D A T A	95 85 80	90 85 85	95 85 85	85 70 80
	X S S	86.7 7.6 CV	86.7 2.9 3.3	88.3 5.8 6.5	78.3 7.6 9.8
	C T A	80 80 80	80 75 75	75 80 70	70 80 75
	M S O	80.0 0.0 CV	76.7 2.9 3.8	75.0 5.0 6.7	75.0 5.0 6.7
C M S 7	D A T A	80 75 70	60 70 55	70 70 65	65 70 60
	X S S	75.0 5.0 6.7	61.7 7.6 12.4	68.3 2.9 4.2	65.0 2.9 7.7
	C V	6.7		4.2	4.2
					7.7
GRANITEROCK					

Table C2. ANOVA Summary, Aggregate Coating

ANOVA						
SOURCE	DF	SS	MS	F	F.05	F.01
E	2	4877.777778	2438.888889	107.5102041	3.29	5.32
A	2	1477.777778	738.888889	32.5714285	3.29	5.32
Q	1	150.0000000	150.0000000	5.5122449	4.14	7.46
EA	4	844.4444444	211.1111111	9.3051224	2.66	3.96
EQ	2	100.0000000	50.0000000	2.2049816	3.29	5.32
AQ	2	77.7777778	38.8888889	1.7142857	3.29	5.32
EAD	4	155.5555555	38.8888889	1.7142857	2.66	3.96
ERROR	36	816.6666667	22.5851852			
TOTAL	53	8500.0000000				

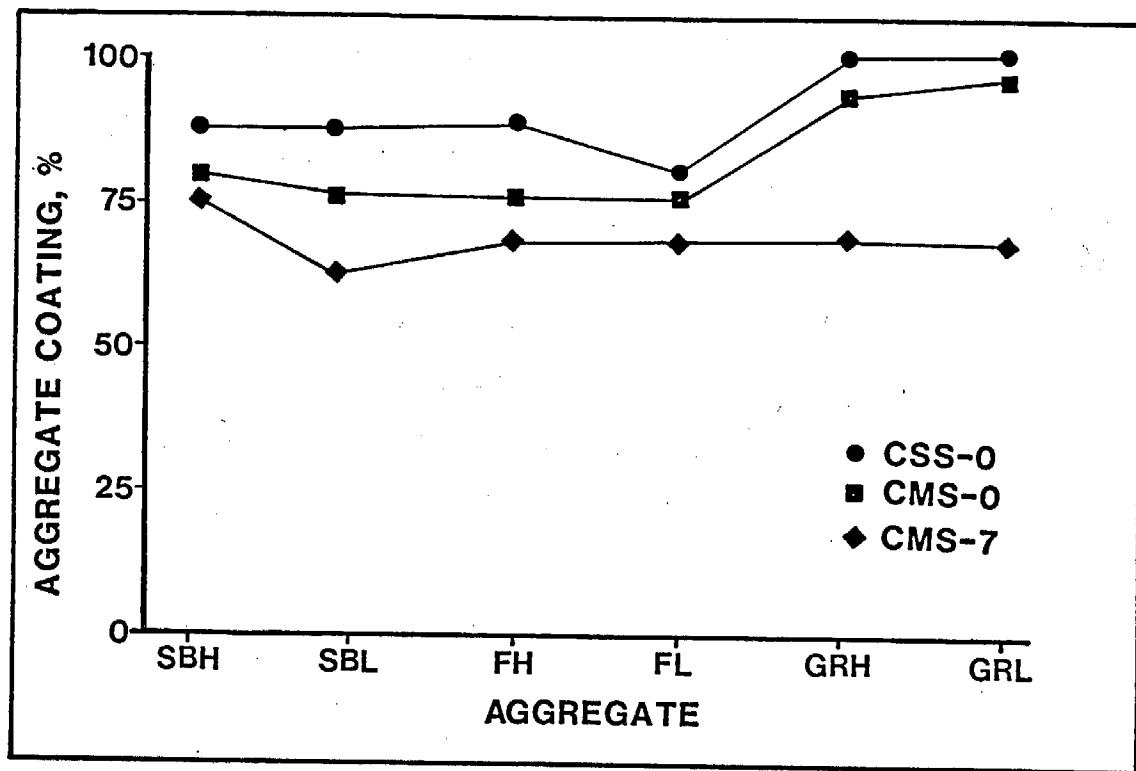


Figure C1. Mean Aggregate Coating at Design Residue Content

<u>SAN BERNARDINO</u>		<u>FRESNO</u>		<u>GRANITEROCK</u>	
<u>HIGH</u>	<u>LOW</u>	<u>HIGH</u>	<u>LOW</u>	<u>HIGH</u>	<u>LOW</u>
CSS-0 86.7	CSS-0 86.7	CSS-0 88.3	CSS-0 78.3	CSS-0 100.0	CSS-0 100.0
CMS-0 80.0	CMS-0 76.7	CMS-0 75.0	CMS-0 75.0	CMS-0 93.3	CMS-0 96.7
CMS-7 75.0	CMS-7 61.7	CMS-7 68.3	CMS-7 65.0	CMS-7 68.3	CMS-7 65.0

Note: Values with a common vertical line are not statistically different.

Figure C2. Newman-Keuls Ranking, Mean Aggregate Coating, %

Table C3. Film Stripping, %

**EMULSION  
AGGREGATE**

		SAN BERNARDINO	FRESNO	GRANITE- ROCK
C S S O	D A T A	5 0	10 5	5 0
	X S S	2.5 3.5	7.5 3.5	2.5 3.5
	C V	141.4	47.1	141.4
	D A T A	0 5	5 7	0 0
C M S O	X S S	2.5 3.5	6.0 1.4	0.0 0.0
	C V	141.4	23.6	0.0
	D A T A	0 0	0 5	0 0
	X S S	0.0 0.0	2.5 3.5	0.0 0.0
7	C V	0.0	141.4	0.0

Table C4. ANOVA Summary, Film Stripping

ANOVA						
SOURCE	DF	SS	MS	F	F.05	F.01
E	2	33.777778	16.888889	2.3565891	4.26	8.02
A	2	68.777778	34.388889	4.7984496	4.26	8.02
E X A	4	9.2222226	2.3055557	.3217054	3.63	6.42
ERROR	9	64.500000	7.1666667			
TOTAL	17	176.2777782				

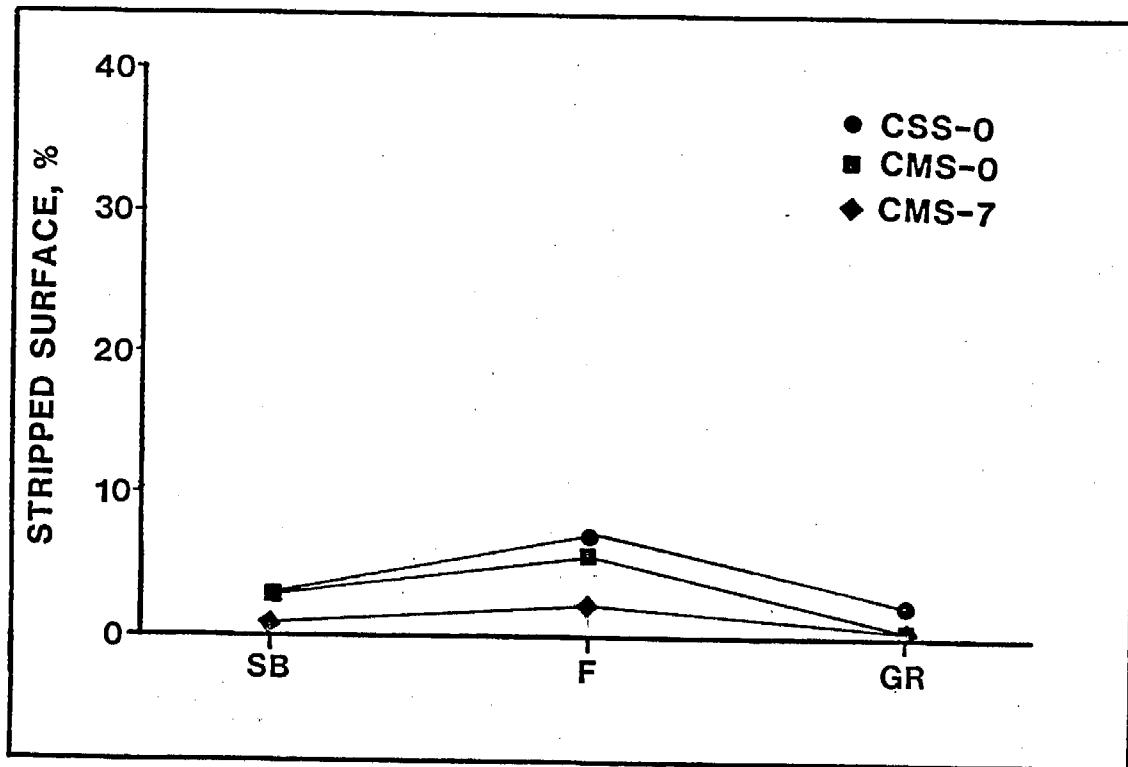


Figure C3. Film Stripping

<u>SAN BERNARDINO</u>		<u>FRESNO</u>	<u>GRANITEROCK</u>
CSS-0	2.5	CSS-0	7.5
CMS-0	2.5	CMS-0	6.0
CMS-7	0.0	CMS-7	2.5

Note: Values with a common vertical line are not statistically different.

Figure C4. Newman-Keuls Ranking,  
Film Stripping, %

Table C5. 2 Day Resilient Modulus at Design Residue Content,  $10^3$  psi

		EMULSION		QUALITY LEVEL		AGGREGATE	
		SAN BERNARDINO		FRESNO		GRANITEROCK	
		HIGH	LOW	HIGH	LOW	HIGH	LOW
C S S O	D A T A	118	170	217	205	160	175
	X S S CV	83	190	191	182	130	185
	D A T A	101	180	204	194	145	180
	X S S CV	25	14	18	16	21	7
C M S O	D A T A	24.6	7.9	9.0	8.4	14.6	3.9
	X S S CV	104	185	155	190	140	215
	D A T A	82	155	154	171	130	180
	X S S CV	93	170	155	181	135	198
C M S 7	D A T A	16	21	1	13	7	25
	X S S CV	16.7	12.5	0.5	7.4	5.2	12.5
	D A T A	80	55	35	73	38	55
	X S S CV	82	48	63	77	45	65
C M S 7	D A T A	81	52	49	75	42	60
	X S S CV	1	5	20	3	5	7
	D A T A	1.8	9.6	40.4	3.8	11.9	11.8
	X S S CV						

Table C6. ANOVA Summary, 2 Day Modulus

ANOVA							
SOURCE	DF	SS	MS	F	F <sub>.05</sub>	F <sub>.01</sub>	
E	2	83226.3888888	41613.1944444	189.5577629	3.57	6.05	
A	2	5441.7222222	2720.8611111	12.3941541	3.57	6.05	
Q	1	8993.3611111	8993.3611111	40.9568480	4.43	8.33	
EA	4	5386.7777779	1346.6944445	6.1345059	2.95	4.61	
EQ	2	3817.0555557	1908.5277778	8.6937872	3.57	6.05	
AQ	2	1442.388889	721.1944445	3.2952081	3.57	6.05	
EAQ	4	5802.4444443	1450.6111111	6.6078704	2.95	4.61	
ERROR	18	3951.5000000	219.5277778				
TOTAL	35	418064.6388889					

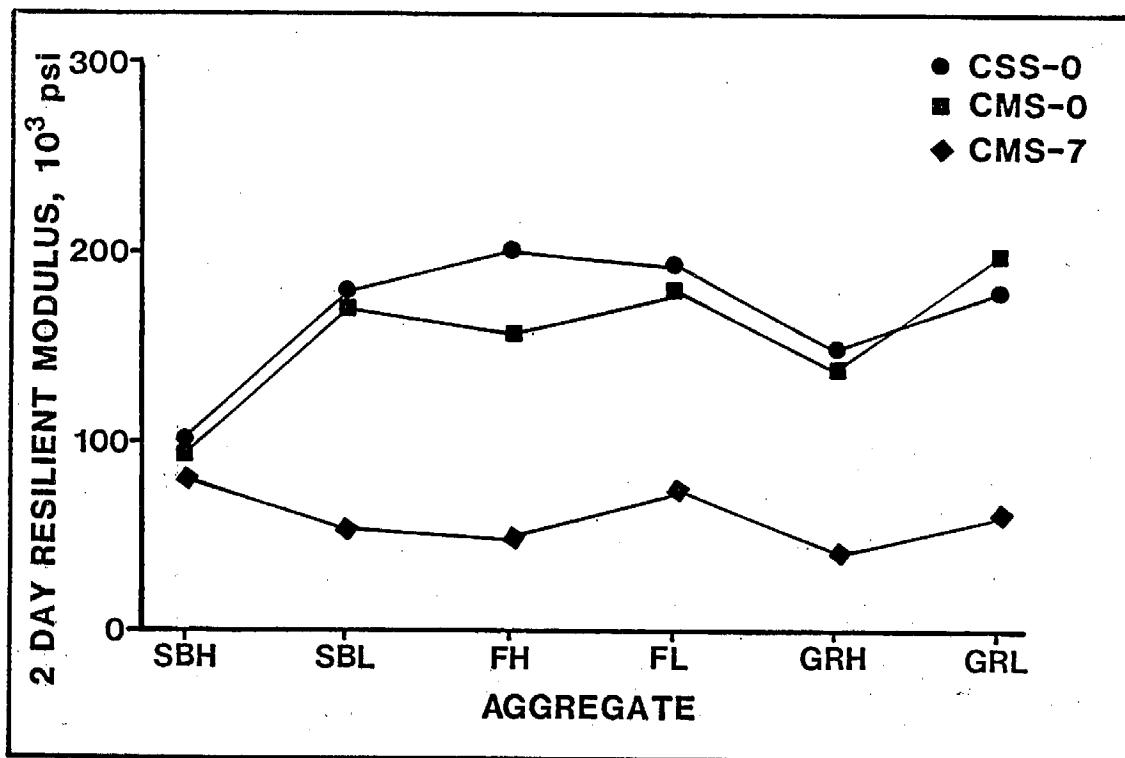


Figure C5. 2 Day Resilient Modulus

<u>SAN BERNARDINO</u>		<u>FRESNO</u>		<u>GRANITEROCK</u>	
<u>HIGH</u>	<u>LOW</u>	<u>HIGH</u>	<u>LOW</u>	<u>HIGH</u>	<u>LOW</u>
CSS-0 101	CSS-0 180	CSS-0 204	CSS-0 194	CSS-0 145	CMS-0 198
CMS-0 93	CMS-0 170	CMS-0 155	CMS-0 181	CMS-0 135	CSS-0 180
CMS-7 81	CMS-7 52	CMS-7 49	CMS-7 75	CMS-7 42	CMS-7 60

Note: Values with a common vertical line are not statistically different.

Figure C6. Newman-Keuls Ranking, 2 Day  
Resilient Modulus,  $10^3$  psi

Table C7. Full Cure Resilient Modulus at Design  
Residue Content,  $10^3$  psi

		EMULSION		QUALITY LEVEL		AGGREGATE	
		SAN BERNARDINO		FRESNO		GRANITEROCK	
		HIGH	LOW	HIGH	LOW	HIGH	LOW
C S S O	D A T A	260	320	482	365	280	320
	X S S	232	280	299	358	240	345
	C V	246	300	391	362	260	333
	S 20	20	28	129	5	28	18
C M M S O	D A T A	8.0	9.4	33.1	1.4	10.9	5.3
	X S S	267	295	253	290	260	395
	C V	250	280	288	387	307	334
	M 12	259	288	271	339	284	365
C M M S 7	D A T A	4.7	3.7	9.2	20.3	11.7	11.8
	X S S	78	110	75	110	80	110
	C V	64	95	73	135	90	135
	M 10	71	103	74	123	85	123
C M M S 7	D A T A	13.9	10.4	1.9	14.4	8.3	14.4
	X S S						
	C V						
	M 14.4						

Table C8. ANOVA Summary, Full Cure Resilient Modulus

ANOVA						
SOURCE	DF	SS	MS	F	F-05	F-01
E	2	359275.0555555	179637.5277778	113.4552807	3.57	6.05
A	2	14506.7222222	7253.3611111	4.5810702	3.57	6.05
Q	1	17161.0000000	17161.0000000	10.9385263	4.43	8.33
EA	4	14739.4444445	3684.8611111	2.3272807	2.95	4.61
EQ	2	4474.1666667	585.5833333	~3698421	3.57	6.05
AQ	2	1921.5000000	960.7500000	.6067895	3.57	6.05
EAQ	4	5535.3333333	1384.0833333	.8741579	2.95	4.61
ERROR	18	26500.0000000	1483.3333333			
TOTAL	35	442841.2222222				

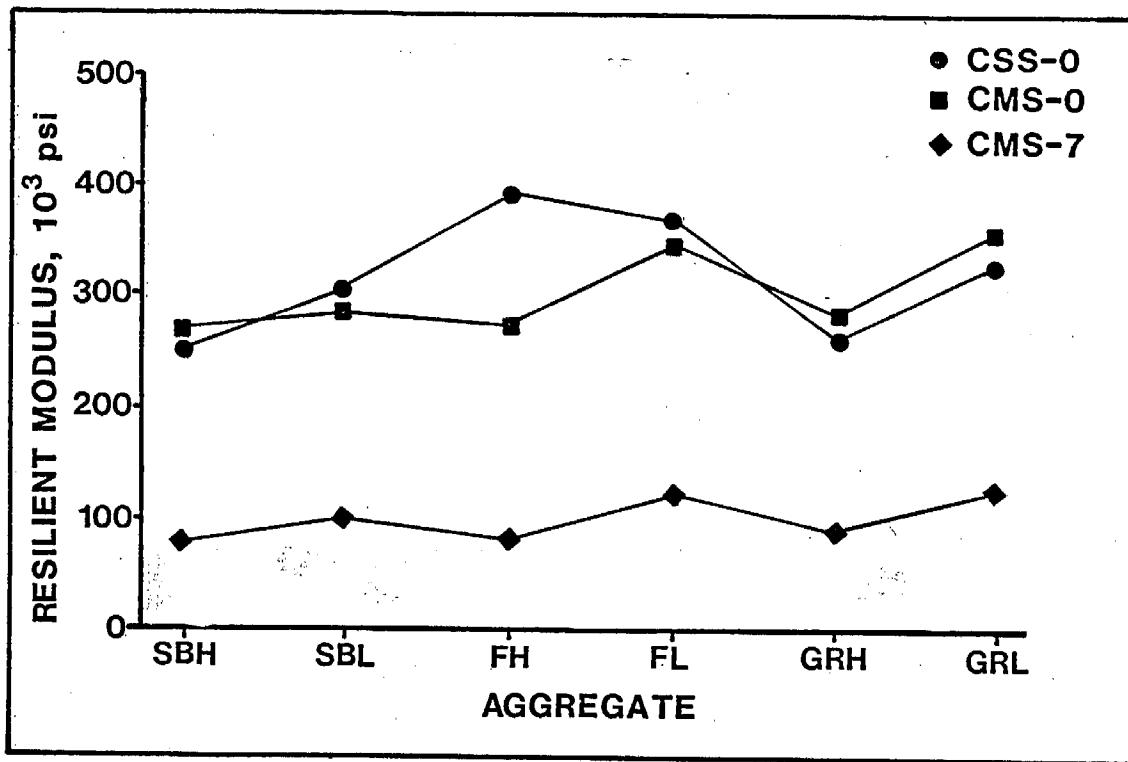


Figure C7. Full Cure Resilient Modulus at Design Residue Content

<u>SAN BERNARDINO</u>		<u>FRESNO</u>		<u>GRANITEROCK</u>	
<u>HIGH</u>	<u>LOW</u>	<u>HIGH</u>	<u>LOW</u>	<u>HIGH</u>	<u>LOW</u>
CMS-0 259	CSS-0 300	CSS-0 391	CSS-0 362	CMS-0 284	CMS-0 365
CSS-0 246	CMS-0 288	CMS-0 271	CMS-0 339	CSS-0 260	CSS-0 333
CMS-7 71	CMS-7 103	CMS-7 74	CMS-7 123	CMS-7 85	CMS-7 123

Note: Values with a common vertical line are not statistically different.

Figure C8. Newman-Keuls Ranking, Full Cure Resilient Modulus,  $10^3$  psi

Table C9. Density at Design Residue Content, pcf

		EMULSION QUALITY LEVEL		AGGREGATE			
		SAN BERNARDINO		FRESNO		GRANITEROCK	
		HIGH	LOW	HIGH	LOW	HIGH	LOW
C S S O	D A T A	135.9	136.5	136.5	134.5	152.0	151.5
	X s s CV	137.2	136.5	135.2	134.5	152.5	151.5
	D A T A	136.6	136.5	135.9	134.5	152.3	151.5
	X s s CV	0.9	0	0.9	0	0.4	0
C M M S O	D A T A	134.8	133.0	132.9	133.5	150.5	149.0
	X s s CV	134.3	133.8	134.0	131.6	149.0	148.5
	D A T A	134.6	133.4	133.5	132.6	149.8	148.8
	X s s CV	0.4	0.6	0.8	1.3	1.1	0.4
C M M S 7	D A T A	137.3	137.5	138.0	137.0	153.7	154.3
	X s s CV	138.5	137.5	137.9	136.0	153.5	154.5
	D A T A	137.9	137.5	138.0	136.5	153.6	154.4
	X s s CV	0.9	0	0.1	0.7	0.1	0.1

Table C10. ANOVA Summary, Density

A N O V A						
SOURCE	DE	-SS	MS	F	F-.05	F-.01
E	2	108.4155555	54.2077778	135.8223660	3.57	6.05
A	2	.2081.0538889	1040.5259445	2505.748063	3.57	6.05
O	1	4.3402778	4.3402778	10.8733473	4.43	8.33
EA	4	1.5994445	.3998611	1.0017398	2.95	4.61
EO	2	-.6528889	-.3344445	.9378567	3.57	6.05
AO	2	1.3772222	.6886111	1.7251218	3.57	6.05
EOAO	4	2.0361111	.5090278	1.2752262	2.95	4.61
ERROR	13	7.1850000	.5991667			
TOTAL	35	2206.6763889				

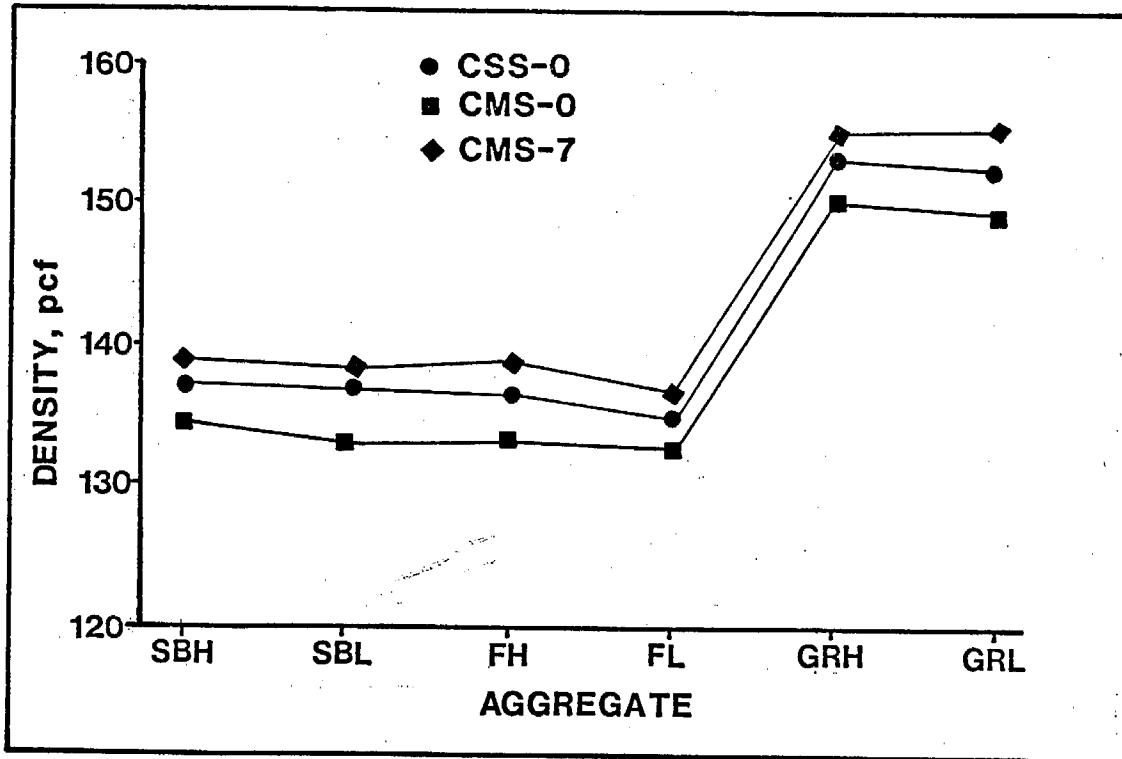


Figure C9. Density at Design Residue Content

<u>SAN BERNARDINO</u>		<u>FRESNO</u>		<u>GRANITEROCK</u>	
<u>HIGH</u>	<u>LOW</u>	<u>HIGH</u>	<u>LOW</u>	<u>HIGH</u>	<u>LOW</u>
CMS-7 137.9	CMS-7 137.5	CMS-7 138.0	CMS-7 136.5	CMS-7 153.6	CMS-7 154.4
CSS-0 136.6	CSS-0 136.5	CSS-0 135.9	CSS-0 134.5	CSS-0 152.3	CSS-0 151.5
CMS-0 134.6	CMS-0 133.4	CMS-0 133.5	CMS-0 132.6	CMS-0 149.8	CMS-0 148.8

Note: Values with a common vertical line are not statistically different.

Figure C10. Newman-Keuls Ranking, Density, pcf

Table C11. Air Voids at Design Residue Content, %

		EMULSION			
		QUALITY LEVEL			
		AGGREGATE			
		SAN BERNARDINO		FRESNO	
		HIGH	LOW	HIGH	LOW
C	D A T A	8.7 7.1	7.0 7.0	7.5 9.2	7.7 8.2
S	X S S O	7.9 1.1 14.3	7.0 0 0	8.4 1.2 14.4	8.0 0.4 4.5
S	C V	9.7 9.0	9.3 9.2	9.3 9.1	8.2 9.3
O	M S S O	9.4 0.5 5.3	9.3 0.1 0.8	9.2 0.1 1.5	8.4 0.4 4.2
M	D A T A	7.7 7.3	6.2 6.1	7.3 6.2	7.1 7.1
S	X S S 7	7.5 0.3 3.8	6.2 0.1 1.2	6.8 0.8 11.5	6.8 0.4 9.6
S	C V	6.2 1.2	6.2 11.5	6.7 9.6	4.8 6.2
O	R	4.8	5.5	5.2	9.6

Table C12. ANOVA Summary, Air Voids

ANOVA						
SOURCE	DF	SS	MS	F	F-.05	F-.01
E	2	38.2650000	19.1325000	69.0150301	3.57	6.05
A	2	2.6816667	1.3408334	4.8366734	3.57	6.05
Q	1	2.6677778	2.6677778	9.5232446	4.43	8.33
EA	4	1.3533333	.3383333	1.2204409	2.95	4.61
EQ	2	1.8105555	.9052778	3.2655310	3.57	6.05
AQ	2	.6572222	.3286111	1.1853707	3.57	6.05
EXQ	4	.8844445	.2211111	.7975952	2.95	4.61
ERROR	18	4.9900000	.2772222			
TOTAL	35.	53.3100000				

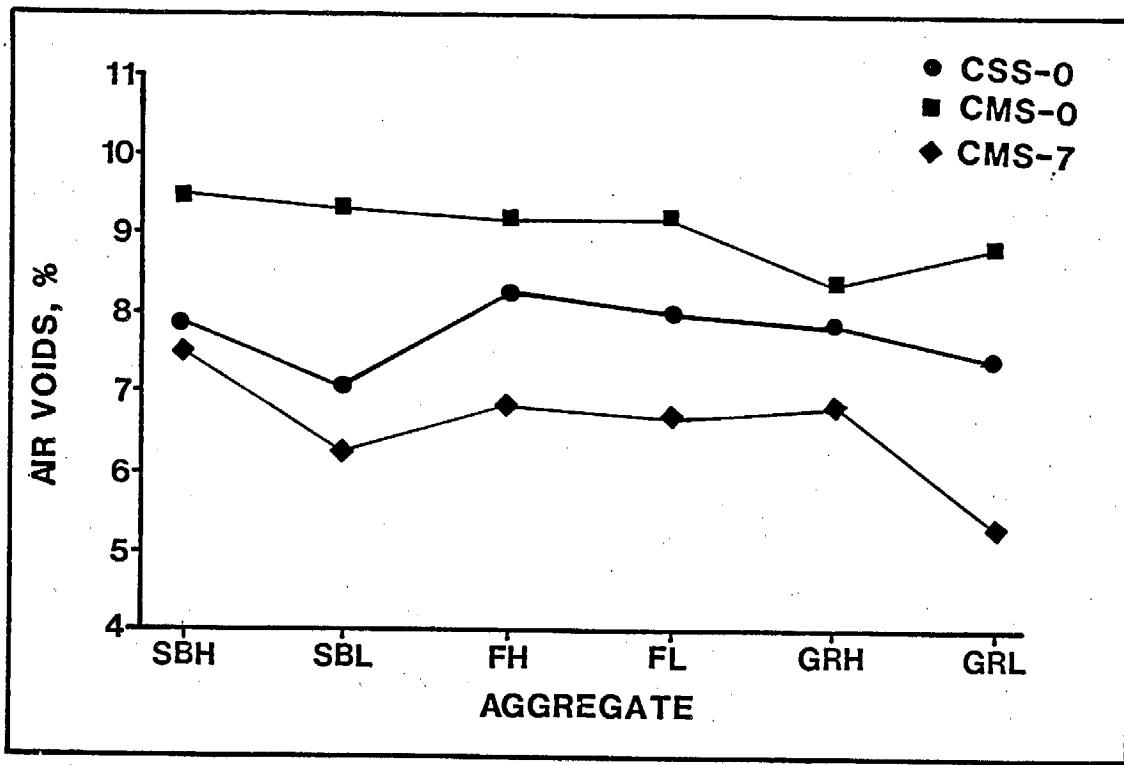


Figure C11. Air Voids at Design Residue Content

<u><b>SAN BERNARDINO</b></u>		<u><b>FRESNO</b></u>		<u><b>GRANITEROCK</b></u>	
<u><b>HIGH</b></u>	<u><b>LOW</b></u>	<u><b>HIGH</b></u>	<u><b>LOW</b></u>	<u><b>HIGH</b></u>	<u><b>LOW</b></u>
CMS-0 9.4	CMS-0 9.3	CMS-0 9.2	CMS-0 9.2	CMS-0 8.4	CMS-0 8.7
CSS-0 7.9	CSS-0 7.0	CSS-0 8.4	CSS-0 8.0	CSS-0 7.9	CSS-0 7.3
CMS-7 7.5	CMS-7 6.2	CMS-7 6.8	CMS-7 6.7	CMS-7 6.8	CMS-7 4.8

Note: Values with a common vertical line are not statistically different.

Figure C12. Newman-Keuls Ranking, Air Voids, %

Table Cl3. Stabilometer Value at Design Residue Content

		EMULSION			
		QUALITY LEVEL			
		AGGREGATE			
		SAN BERNARDINO		FRESNO	
		HIGH	LOW	HIGH	LOW
C	D A T A	27.2 31.13	27.0 26.5	39.3 32.7	38.0 32.5
S	X s s CV	29.3 2.9 9.9	26.8 0.4 1.3	36.0 4.7 13.0	35.3 3.9 11.0
S	D A T A	37.5 34.4	34.0 35.0	30.7 37.7	41.5 36.7
O	X s s CV	36.0 2.2 6.1	34.5 0.7 2.1	34.2 5.0 14.5	39.1 3.3 8.5
C	D A T A	23.5 23.5	13.0 12.0	21.3 23.3	15.0 20.0
M	X s s CV	23.5 0 0	12.5 0.7 5.7	22.3 1.4 6.3	17.5 3.5 20.2
M	D A T A	23.5 23.5	12.5 12.0	22.3 23.3	15.0 20.0
7	X s s CV	23.5 0 0	12.5 0.7 5.7	22.3 1.4 6.3	17.5 3.5 20.2

Table Cl4. ANOVA Summary, Stabilometer Value

ANOVA						
SOURCE	DF	SS	MS	F	F.05	F.01
E	2	708.6172721	354.3086361	50.5343236	3.57	6.05
A	2	.97.0209389	48.5104695	5.9189501	3.57	6.05
O	1	175.6950250	175.6950250	25.0590258	4.43	8.33
EA	4	671.8347112	167.9586778	23.9556063	2.95	4.61
EO	2	84.8642554	42.9320250	-5.3380519	3.57	6.05
AO	2	94.1227166	47.0613583	5.7122663	3.57	6.05
EOA	4	28.9279333	7.2319833	1.0314831	2.95	4.61
ERROR	18	126.2024500	7.0112472			
TOTAL	35	1984.2850972				

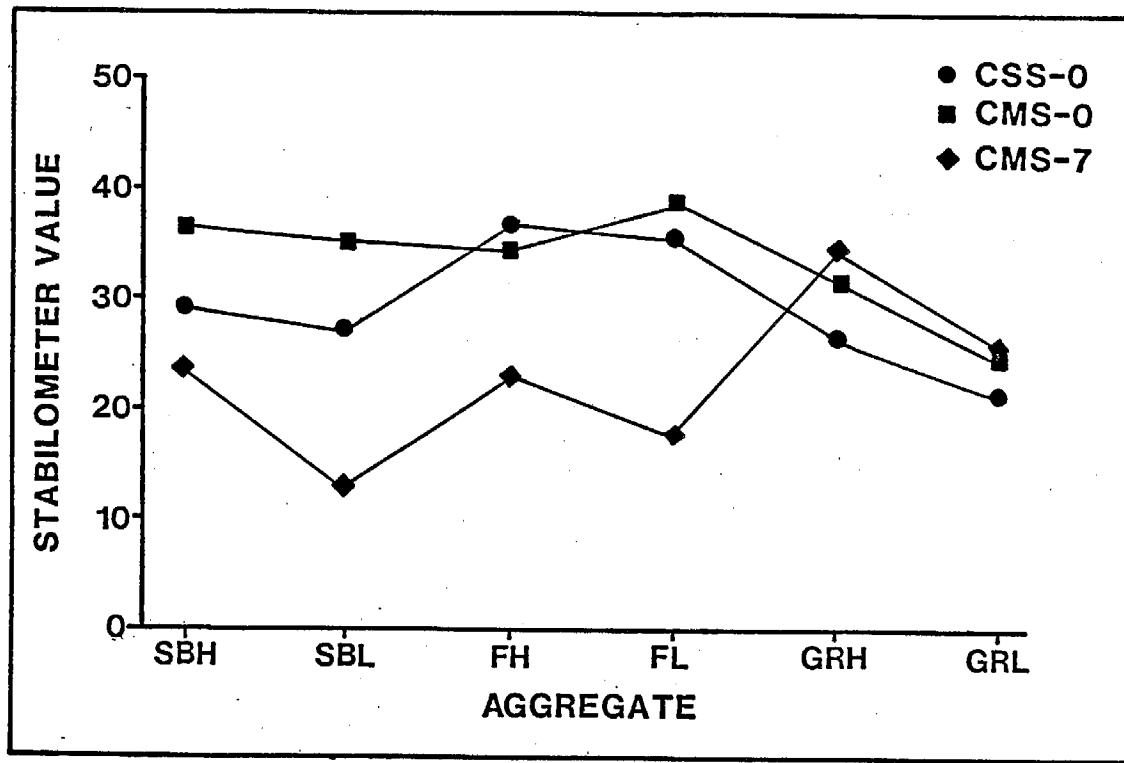


Figure C13. Stabilometer Value at Design Residue Content

<u>SAN BERNARDINO</u>		<u>FRESNO</u>		<u>GRANITEROCK</u>	
<u>HIGH</u>	<u>LOW</u>	<u>HIGH</u>	<u>LOW</u>	<u>HIGH</u>	<u>LOW</u>
CMS-0 36.0	CMS-0 34.5	CSS-0 36.0	CMS-0 39.1	CMS-7 35.0	CMS-7 25.0
CSS-0 29.3	CSS-0 26.8	CMS-0 34.2	CSS-0 35.3	CMS-0 32.5	CMS-0 24.3
CMS-7 23.5	CMS-7 12.5	CMS-7 22.3	CMS-7 17.5	CSS-0 27.0	CSS-0 21.0

Note: Values with a common vertical line are not statistically different.

Figure C14. Newman-Keuls Ranking, Stabilometer Value

Table C15. Cohesiometer Value at Design Residue Content

		EMULSION		QUALITY LEVEL		AGGREGATE	
		SAN BERNARDINO		FRESNO		GRANITEROCK	
		HIGH	LOW	HIGH	LOW	HIGH	LOW
C S S O	D A T A	193	360	280	465	275	250
	S	234	345	183	375	160	225
	X	214	353	232	420	218	238
	CV	29	11	69	64	81	18
C M S O	D A T A	280	440	230	355	200	320
	S	252	430	219	450	140	240
	X	266	435	225	403	170	280
	CV	20	7	8	.67	42	57
C M S 7	D A T A	80	190	122	245	130	170
	S	82	180	192	235	120	180
	X	81	185	157	240	125	175
	CV	1	7	50	7	7	7
		1.8	3.8	31.5	3.0	5.7	4.0

Table C16. ANOVA Summary, Cohesiometer Value

ANOVA						
SOURCE	DF	SS	MS	F	F.05	F.01
E	2	130971.722222	65485.8611111	40.2309084	3.57	6.05
A	2	38806.722222	19403.3611111	41.9203579	3.57	6.05
Q	1	120524.6904445	120524.6904445	74.0437379	4.43	8.33
EA	4	23118.4444445	5779.6111111	3.5505749	2.95	4.61
EQ	2	-8066.722222	-4033.3611111	-2.4776759	3.57	6.05
AQ	2	14206.722222	7103.3511111	4.3639141	3.57	6.05
EAQ	4	5035.1111111	1251.2777778	.7587162	2.95	4.61
ERROR	18	29299.5000000	1627.7500000			
TOTAL	35	369999.6388888				

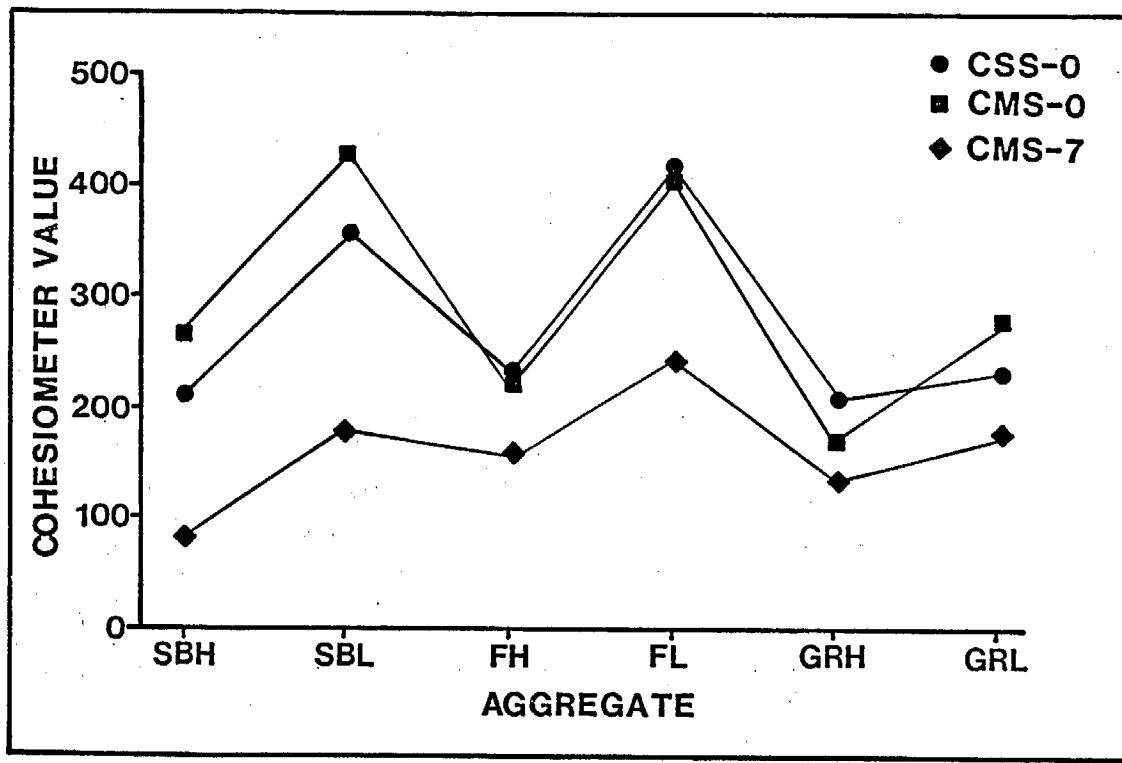


Figure C15. Cohesiometer Value at Design Residue Content

SAN BERNARDINO		FRESNO		GRANITEROCK	
HIGH	LOW	HIGH	LOW	HIGH	LOW
CMS-0 266	CMS-0 435	CSS-0 232	CSS-0 420	CSS-0 218	CMS-0 280
CSS-0 214	CSS-0 353	CMS-0 225	CMS-0 403	CMS-0 170	CSS-0 238
CMS-7 81	CMS-7 185	CMS-7 157	CMS-7 240	CMS-7 125	CMS-7 175

Note: Values with a common vertical line are not statistically different.

Figure C16. Newman-Keuls Ranking, Cohesiometer Value

Table C17. Swell at Design Residue Content, in.

		EMULSION			
		QUALITY LEVEL			
		AGGREGATE			
		SAN BERNARDINO		FRESNO	
		HIGH	LOW	HIGH	LOW
C	D	0.000	0.003	0.000	0.008
S	A	0.000	0.005	0.000	0.007
S	T	0.000	0.004	0.000	0.009
O	A				
	X	0.0000	0.0040	0.0000	0.0080
	s	0.0000	0.0010	0.0000	0.0010
	CV	0.0	25.0	0.0	12.5
C	D	0.000	0.045	0.020	0.036
M	A	0.006	0.029	0.018	0.040
S	T	0.007	0.040	0.022	0.039
O	A				
	X	0.0043	0.0380	0.0200	0.0383
	s	0.0038	0.0082	0.0020	0.0021
	CV	87.4	21.5	10.0	5.4
C	D	0.000	0.004	0.000	0.003
M	A	0.000	0.002	0.000	0.000
S	T	0.000	0.001	0.000	0.000
7	A				
	X	0.0000	0.0023	0.0000	0.0010
	s	0.0000	0.0015	0.0000	0.0017
	CV	0.0	65.5	0.0	173.2

Table C18. ANOVA Summary, Swell

ANOVA						
SOURCE	DF	-SS-	-MS-	F	F.05	F.01
E	2	.0031905	.0015953	757.6385224	3.29	5.32
A	2	.0012203	.0006102	299.7810926	3.29	5.32
Q	1	.0008680	.0008680	412.2427441	4.14	8.46
EA	4	.0016535	.0004134	196.3258575	2.66	3.96
EQ	2	.0007951	.0003976	128.8165227	3.29	5.32
AQ	2	.0004958	.0002479	117.7351470	3.29	5.32
EAQ	4	.0006609	.0001652	78.4709763	2.66	3.96
ERROR	36	.0000759	.0000021			
TOTAL	53	.0089599				

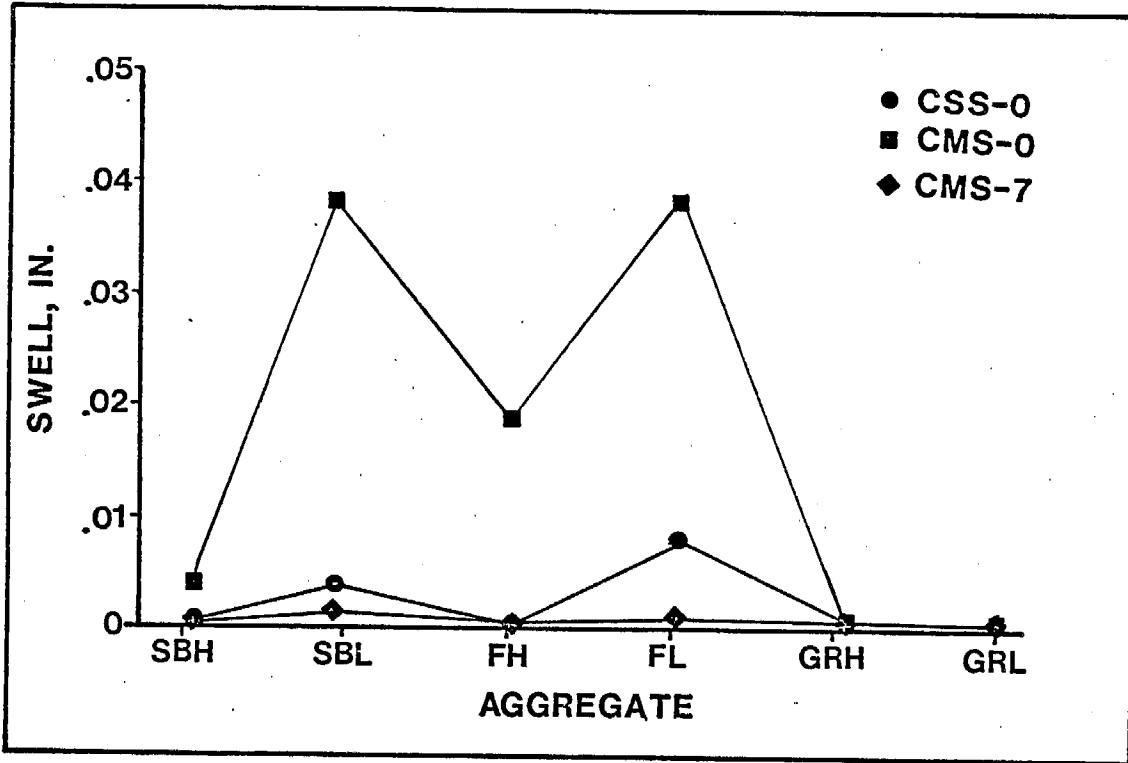


Figure C17. Swell at Design Residue Content

<u>SAN BERNARDINO</u>		<u>FRESNO</u>		<u>GRANITEROCK</u>	
<u>HIGH</u>	<u>LOW</u>	<u>HIGH</u>	<u>LOW</u>	<u>HIGH</u>	<u>LOW</u>
CMS-0 0.0043	CMS-0 -.0380	CMS-0 0.0200	CMS-0 0.0303	CMS-0 0.0003	CSS-0 0.0007
CSS-0 0.0000	CSS-0 0.0040	CSS-0 0.0000	CSS-0 0.0080	CSS-0 0.0000	CMS-0 0.0000
CMS-7 0.0000	CMS-7 0.0023	CMS-7 0.0000	CMS-7 0.0010	CMS-7 0.0000	CMS-7 0.0000

Note: Values with a common vertical line are not statistically different.

Figure C18. Newman-Keuls Ranking,  
Swell, in.

Table C19. MVS Conditioned Stabilometer Value at Design Residue Content

		EMULSION			
		QUALITY LEVEL			
		AGGREGATE			
		SAN BERNARDINO		FRESNO	
		HIGH	LOW	HIGH	LOW
C S S O	D A T A	19.8 22.7 19.7	13.7 14.5 13.5	28.7 17.8 25.2	12.4 8.3 -
	X S s	20.7 1.7	13.9 0.5	23.9 5.6	10.4 2.9
	CV	8.2	3.8	23.3	28.0
	C M S O	19.7 19.1 15.8	14.5 9.2 -	14.5 10.0 10.5	9.0 8.0 -
C M S 7	D A T A	19.7 19.1 15.8	14.5 9.2 -	14.5 10.0 10.5	9.0 8.0 -
	X S s	18.2 2.1	11.9 3.7	11.7 2.5	8.5 0.7
	CV	11.5	31.6	21.1	8.3
	C M S 7	21.0 22.0 21.6	20.2 8.7 13.8	18.5 18.1 22.3	9.8 8.8 7.7
		X S s	21.5 0.5	14.2 5.8	8.8 1.1
		CV	2.3	40.5	11.8
				12.0	2.2
					9.6

Table C20. ANOVA Summary, MVS Conditioned Stabilometer Value

ANOVA						
SOURCE	DF	SS	MS	F	F <sub>0.05</sub>	F <sub>0.01</sub>
E	2	401.7137037	200.8568519	16.6553085	3.29	5.32
A	2	-583.1137037	-291.5568519	24.1762692	3.29	5.32
Q	1	1465.3646296	1465.3646296	121.5099198	4.14	7.46
EA	4	278.4740740	69.6185185	5.7728571	2.66	3.96
EQ	2	-112.0359259	-56.0179630	4.6450815	3.29	5.32
AQ	2	35.5470370	17.7735185	1.4738030	3.29	5.32
EAO	4	127.9474075	31.9868519	2.6523909	2.66	3.96
ERROR	36	434.1466667	12.0596296			
TOTAL	53	-3438.3431481				

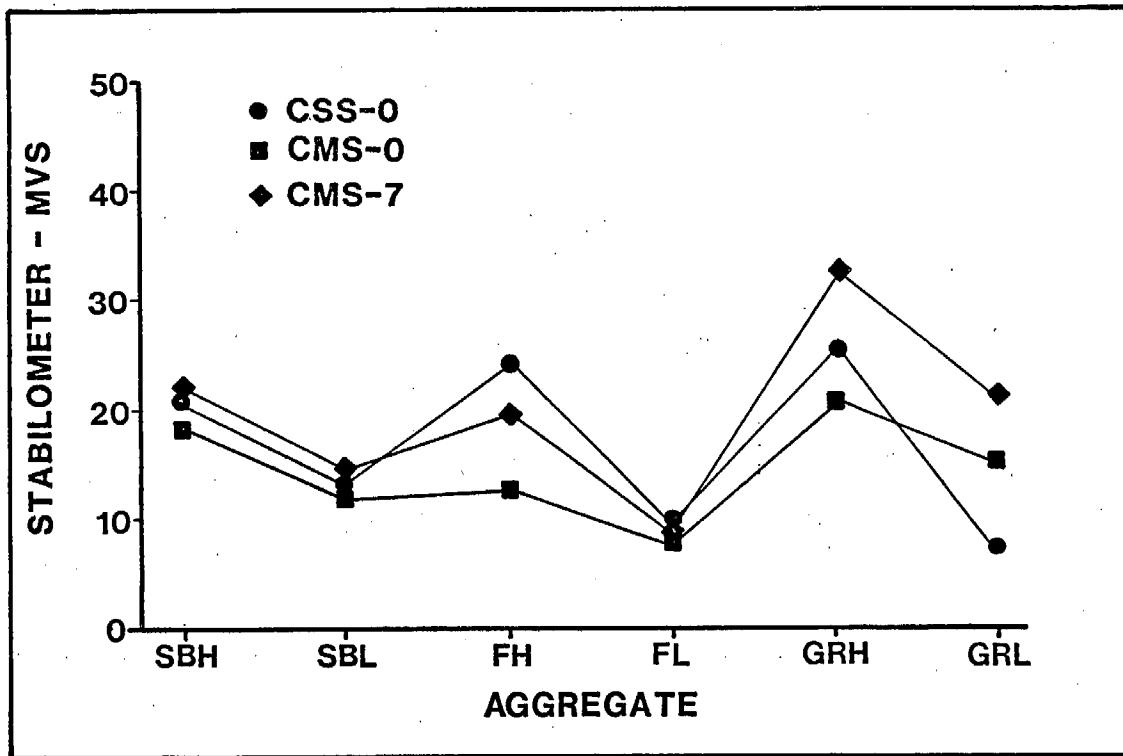


Figure C19. MVS Conditioned Stabilometer Value at Design Residue Content

<u>SAN BERNARDINO</u>		<u>FRESNO</u>		<u>GRANITEROCK</u>	
<u>HIGH</u>	<u>LOW</u>	<u>HIGH</u>	<u>LOW</u>	<u>HIGH</u>	<u>LOW</u>
CMS-7 21.5	CMS-7 14.2	CSS-0 23.9	CSS-0 10.4	CMS-7 33.8	CMS-7 21.7
CSS-0 20.7	CSS-0 13.9	CMS-7 19.6	CMS-7 8.8	CSS-0 25.8	CMS-0 15.6
CMS-0 18.2	CMS-0 11.9	CMS-0 11.7	CMS-0 8.5	CMS-0 20.5	CSS-0 7.3

Note: Values with a common vertical line are not statistically different.

Figure C20. Newman-Keuls Ranking, MVS Conditioned Stabilometer Value

Table C21. MVS Conditioned Cohesiometer Value at Design Residue Content

		EMULSION			
		QUALITY LEVEL			
		AGGREGATE			
		SAN BERNARDINO		FRESNO	
		HIGH	LOW	HIGH	LOW
C S S O	D	135	70	105	148
	A	104	85	66	197
	T	104	51	136	-
	A				
C M S O	X	114	69	102	173
	S	18	17	35	35
	CV	15.7	24.8	34.3	20.1
C M S O	D	128	73	69	158
	A	85	59	36	110
	T	174	-	65	-
	A				
C M S O	X	119	66	56	134
	S	31	10	18	34
	CV	25.6	15.0	31.8	25.3
C M S 7	D	141	185	125	192
	A	79	60	201	164
	T	52	63	96	126
	A				
C M S 7	X	91	103	141	161
	S	46	71	54	33
	CV	50.3	69.5	38.6	20.6

Table C22. ANOVA Summary, MVS Conditioned Cohesiometer Value

ANOVA						
SOURCE	DF	SS	MS	F	F.05	F.01
E	2	19909.000000	9954.500000	4.1805138	3.29	5.32
A	2	3943.444444	1971.722222	4.8280488	3.29	5.32
Q	1	411.1296296	411.1296296	0.1726589	4.14	7.46
EA	4	6198.222222	1549.5555556	0.6507548	2.66	3.96
EQ	2	1721.1481484	860.5740741	0.3614086	3.29	5.32
AQ	2	7547.3703704	3823.6851852	1.6058033	3.29	5.32
EQ	4	4466.5785186	1116.6296297	0.4689422	2.66	3.96
ERROR	36	85722.000000	2381.1666667			
TOTAL	53	130048.8333333				

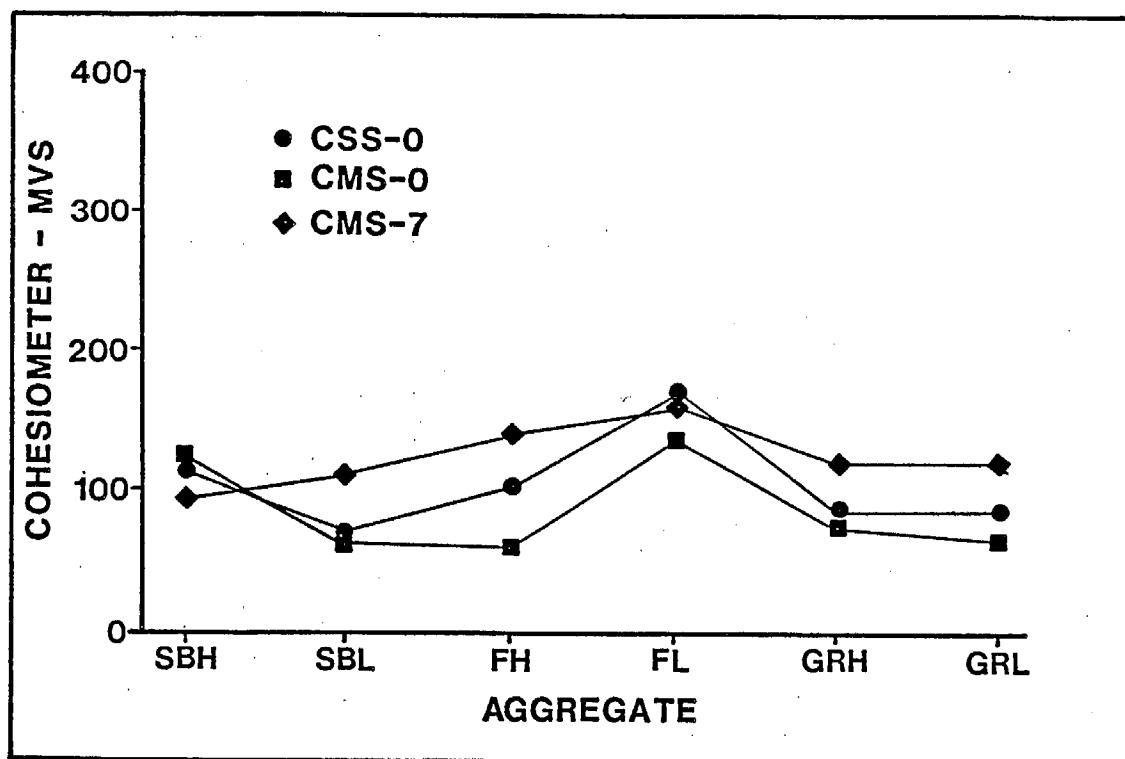


Figure C21. MVS Conditioned Cohesiometer Value at Design Residue Content

<u>SAN BERNARDINO</u>		<u>FRESNO</u>		<u>GRANITEROCK</u>	
<u>HIGH</u>	<u>LOW</u>	<u>HIGH</u>	<u>LOW</u>	<u>HIGH</u>	<u>LOW</u>
CMS-0 119	CMS-7 103	CMS-7 141	CSS-0 173	CMS-7 127	CMS-7 126
CSS-0 114	CSS-0 69	CSS-0 102	CMS-7 161	CSS-0 93	CSS-0 91
CMS-7 91	CMS-0 66	CMS-0 56	CMS-0 134	CMS-0 80	CMS-0 77

Note: Values with a common vertical line are not statistically different.

Figure C22. Newman-Keuls Ranking, MVS Conditioned Cohesiometer Value

Table C23. Surface Abrasion at Design Residue Content, grams

EMULSION  
QUALITY LEVEL  
AGGREGATE

		SAN BERNARDINO		FRESNO		GRANITEROCK	
		HIGH	LOW	HIGH	LOW	HIGH	LOW
C S S O	D A T A	72.4 81.1 63.7	128.9 - 127.6	62.7 62.8 69.5	62.2 94.0 142.7	47.5 40.7 127.6	80.3 79.0 49.8
	X S CV	72.4 12.3 17.0	128.3 0.9 0.7	65.0 3.9 6.0	99.6 40.5 40.7	71.9 48.3 67.2	69.7 17.2 24.7
	D A T A	121.7 39.3 126.0	207.5 287.9 187.5	194.3 119.5 201.2	124.1 122.4 120.8	67.6 57.4 55.0	98.6 78.7 81.5
	X S CV	95.7 48.9 51.1	227.6 53.2 23.3	171.7 45.3 26.4	122.4 1.7 1.3	60.0 6.7 11.2	86.3 10.8 12.5
C M S O 7	D A T A	64.2 62.0 77.4	10.2 42.6 66.2	59.7 36.9 47.0	58.8 60.1 29.0	30.1 26.3 39.3	23.8 28.4 22.7
	X S CV	67.9 8.3 12.3	39.7 28.1 70.9	47.9 11.4 23.9	49.3 17.6 35.7	31.9 6.7 21.0	25.0 3.0 12.1

Table C24. ANOVA Summary, Surface Abrasion

ANOVA							
SOURCE	DF	SS	MS	F	F.05	F.01	
E	2	53036.1248149	31518.0624075	43.2152433	3.29	5.32	
A	2	22093.8237037	11046.9118519	15.1470615	3.29	5.32	
Q	1	4469.9201852	4469.9201852	6.1289668	4.14	7.46	
EA	4	9733.1796296	2433.2949074	3.3354318	2.66	3.96	
EQ	2	5951.6003703	2975.8001851	4.9802922	3.29	5.32	
AQ	2	8501.7525926	4250.8752963	5.8286230	3.29	5.32	
EAQ	4	19647.5151852	4911.8787963	5.7349619	2.66	3.96	
ERROR	36	26255.1800000	729.3105556				
TOTAL	53	159689.0964815					

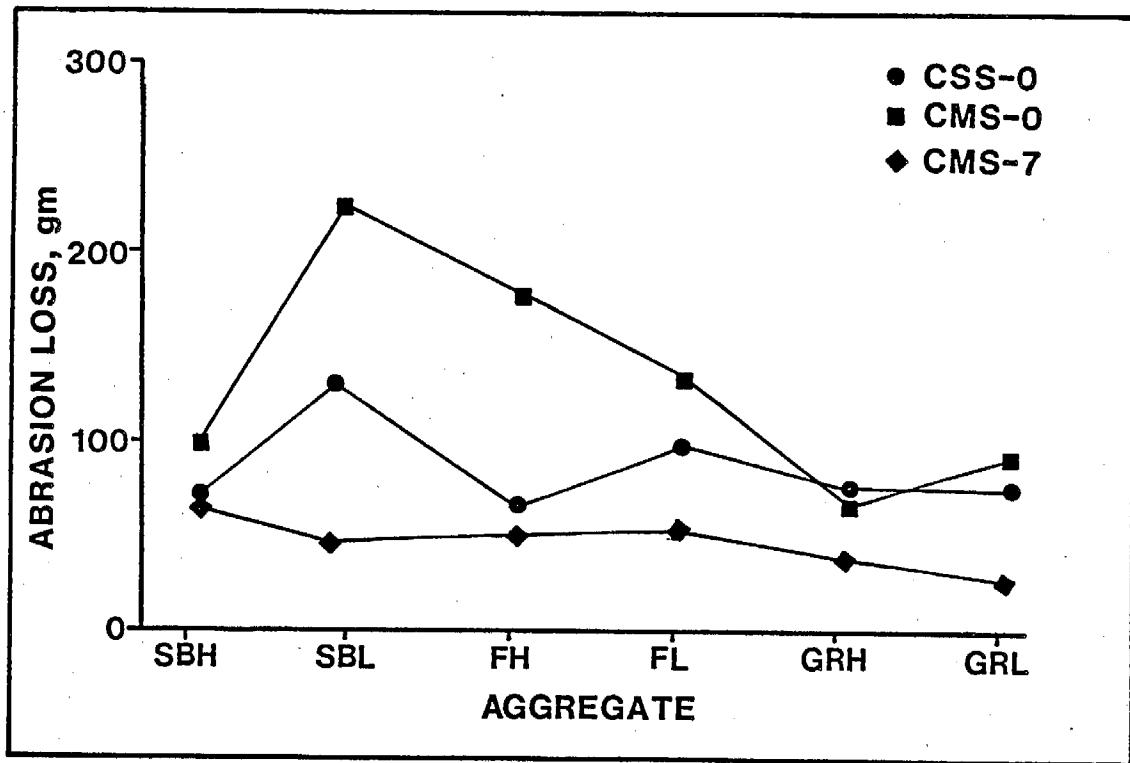


Figure C23. Surface Abrasion at Design Residue Content

SAN BERNARDINO		FRESNO		GRANITEROCK	
HIGH	LOW	HIGH	LOW	HIGH	LOW
CMS-0 95.7	CMS-0 227.6	CMS-0 171.7	CMS-0 122.4	CSS-0 71.9	CMS-0 86.3
CSS-0 72.4	CSS-0 128.3	CSS-0 65.0	CSS-0 99.6	CMS-0 60.0	CSS-0 69.7
CMS-7 67.9	CMS-7 39.7	CMS-7 47.9	CMS-7 49.3	CMS-7 31.9	CMS-7 25.0

Note: Values with a common vertical line are not statistically different.

Figure C24. Newman-Keuls Ranking,  
Surface Abrasion, grams

**APPENDIX D**

**DATA ANALYSIS, SULFUR-EXTENDED-ASPHALT  
AND CONVENTIONAL EMULSIONS**

Table D1. Aggregate Coating at Design Residue Content, %

		EMULSION			
		QUALITY LEVEL			
		AGGREGATE			
		SAN BERNARDINO		FRESNO	
		HIGH	LOW	HIGH	LOW
15%	SS	75 85 85	85 80 85	80 75 70	65 70 70
	SEA	X S CV	81.7 5.8 7.1	83.3 2.9 3.5	75.0 5.0 6.7
	SS	D A T A	85 80 85	75 85 85	70 80 70
	SEA	X S CV	83.3 2.9 3.5	78.3 2.9 3.7	81.7 5.8 7.1
	CM	D A T A	80 75 70	60 70 55	70 70 65
	S	X S CV	75.0 5.0 6.7	61.7 7.6 12.4	68.3 2.9 4.2
	7				

Table D2. ANOVA Summary, Aggregate Coating

ANOVA						
SOURCE	DF	SS	MS	F	F.05	F.01
E	2	2359.2592593	1179.6296297	55.3913043	3.29	5.32
A	2	639.8186148	319.9074674	15.3217391	3.29	5.32
G	1	362.9629630	362.9629630	17.0434783	4.14	7.46
EA	4	399.0780741	99.7685185	4.6847826	2.56	3.96
EG	2	25.9259259	12.9629629	.6086957	3.29	5.32
AG	2	12.0377372	6.0195185	.2826087	3.29	5.32
EAC	4	165.7407407	41.4351852	1.9456522	2.66	3.96
EROR	36	766.6666667	21.2952063			
TOTAL	53	4731.4614815				

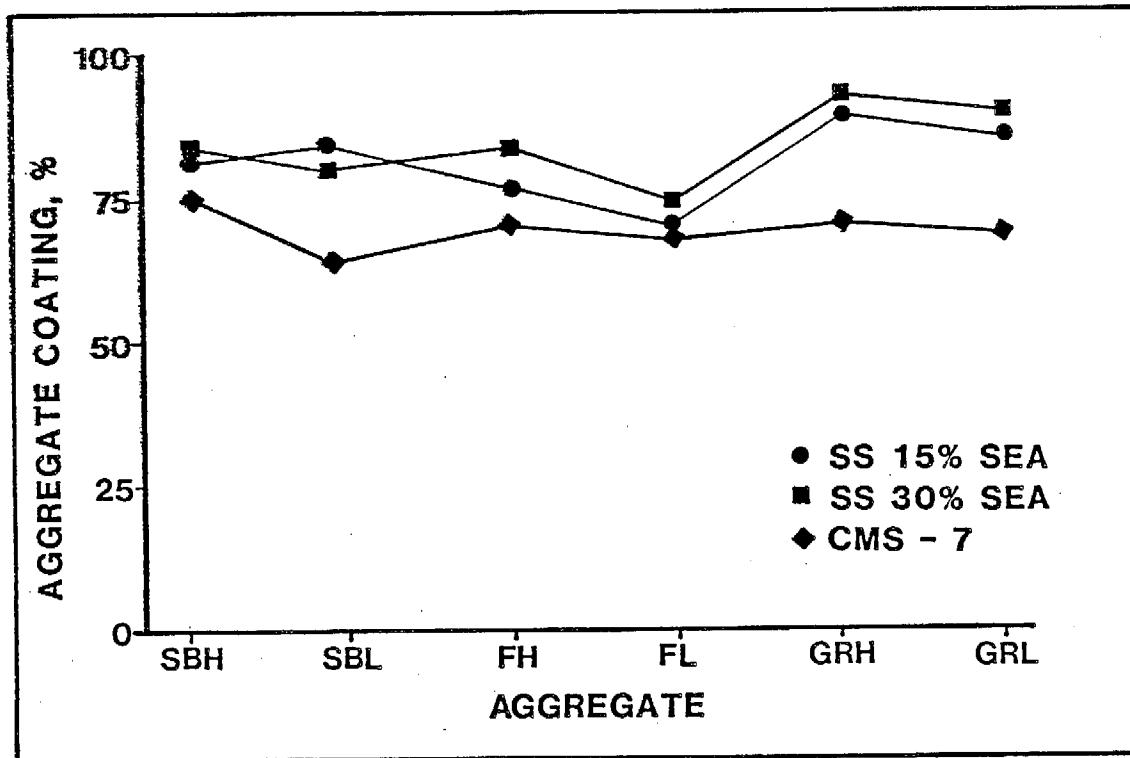


Figure D1. Mean Aggregate Coating at Design Residue Content

<u>SAN BERNARDINO</u>		<u>FRESNO</u>		<u>GRANITEROCK</u>	
<u>HIGH</u>	<u>LOW</u>	<u>HIGH</u>	<u>LOW</u>	<u>HIGH</u>	<u>LOW</u>
SS-30% 83.3	SS-15% 83.3	SS-30% 81.7	SS-30% 73.3	SS-30% 90.0	SS-30% 88.3
SS-15% 81.7	SS-30% 78.3	SS-15% 75.0	SS-15% 68.3	SS-15% 88.3	SS-15% 83.3
CMS-7 75.0	CMS-7 61.7	CMS-7 68.3	CMS-7 65.0	CMS-7 68.3	CMS-7 65.0

Note: Values with a common vertical line are not statistically different.

Figure D2. Newman-Keuls Ranking,  
Mean Aggregate Coating, %

Table D3. Film Stripping, %

**EMULSION  
AGGREGATE**

		SAN BERNARDINO	FRESNO	GRANITE- ROCK
S S 15	D A T A	30 15	20 30	15 25
	X	22.5	25.0	20.0
	s	10.6	7.1	7.1
30	CV	47.1	28.3	35.4
	D A T A	25 25	0 0	5 0
	X	25.0	0.0	2.5
7	s	0.0	0.0	3.5
	CV	0.0	0.0	141.3
	D A T A	0 0	0 5	0 0
CMS	X	0.0	2.5	0.0
	s	0.0	3.5	0.0
	CV	0.0	141.3	0.0

Table D4. ANOVA Summary, Film Stripping

ANOVA						
SOURCE	DF	SS	MS	F	F.05	F.01
E	2	1433.3333333	716.6666667	27.1578947	4.26	8.02
A	2	233.3333333	116.6666667	4.4210526	4.26	8.02
ExA	4	558.3333335	139.5833334	5.2894737	3.63	6.42
ERROR	9	237.5000000	26.3888889			
TOTAL	17	2462.5000002				

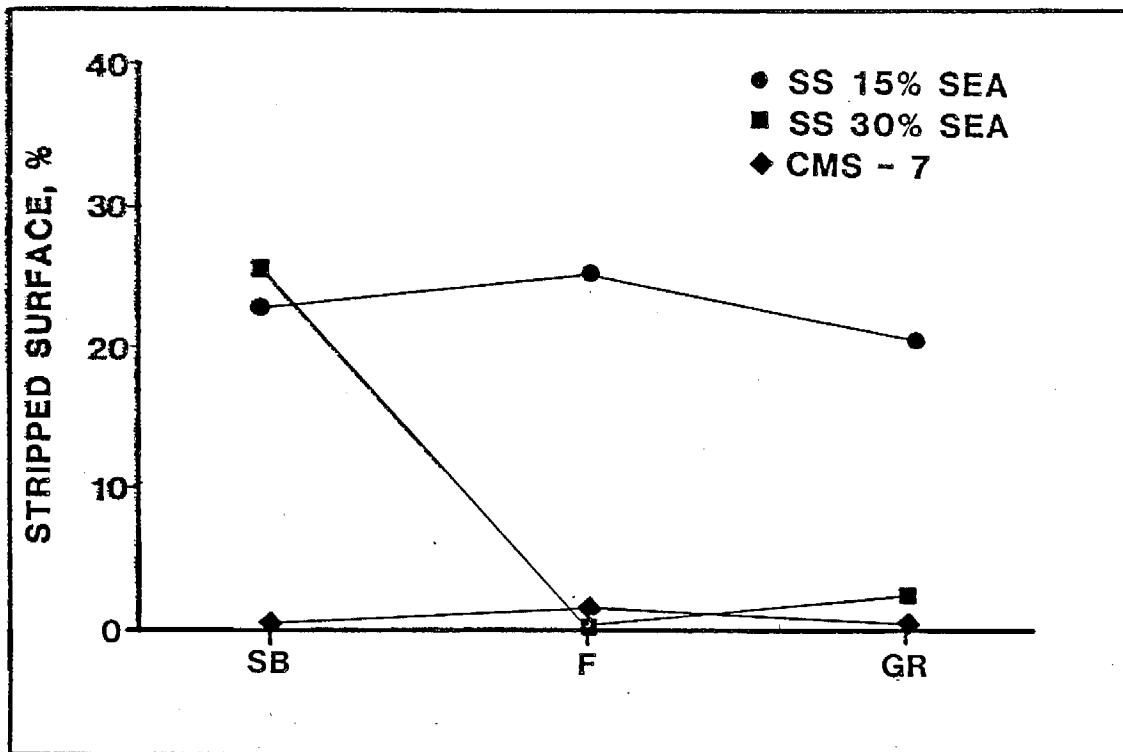


Figure D3. Film Stripping

<u>SAN BERNARDINO</u>		<u>FRESNO</u>	<u>GRANITEROCK</u>
SS-30	25.0	SS-15	25.0
SS-15	22.5	CMS-7	2.5
CMS-7	0.0	SS-30	0.0

Note: Values with a common vertical line are not statistically different.

Figure D4. Newman-Keuls Ranking,  
Film Stripping, %

Table D5. 2 Day Resilient Modulus at Design Residue  
 $10^3$  psi

		EMULSION		QUALITY LEVEL		AGGREGATE	
		SAN BERNARDINO		FRESNO		GRANITEROCK	
		HIGH	LOW	HIGH	LOW	HIGH	LOW
15%	SS	D A T A	141 122	139 141	171 165	185 197	110 159
	SEA	X S CV	132 13 10.2	140 1 1.0	168 4 2.5	191 9 4.4	135 35 25.8
	SS	D A T A	158 140	189 198	184 187	212 201	178 173
	SEA	X S CV	149 13 8.5	194 6 3.3	186 2 1.1	207 8 3.8	176 4 2.0
	C M S	D A T A	80 82	55 48	35 63	73 77	38 45
	7	X S CV	81 1 1.8	52 5 9.6	49 20 40.4	75 3 3.8	42 5 11.9

Table D6. ANOVA Summary, 2 Day Modulus

ANOVA						
SOURCE	DF	SS	MS	F	F.05	F.01
E	2	104734.3888889	52367.1944445	371.5181747	3.57	6.05
A	2	2911.0555556	1455.5277778	10.3289966	3.57	6.05
Q	1	3383.3611112	3383.3611112	24.0095590	4.43	8.33
EA	4	3124.1111111	781.0222228	5.5424798	2.95	4.61
EQ	2	1219.7222222	609.3611111	4.3242657	3.57	6.05
10	2	621.0555555	310.5277778	2.2036270	3.57	6.05
EQ10	4	1569.1111111	417.2777778	-2.3611570	2.95	4.61
ERROR	18	2534.5000000	140.9166667			
TOTAL	35	120198.3055556				

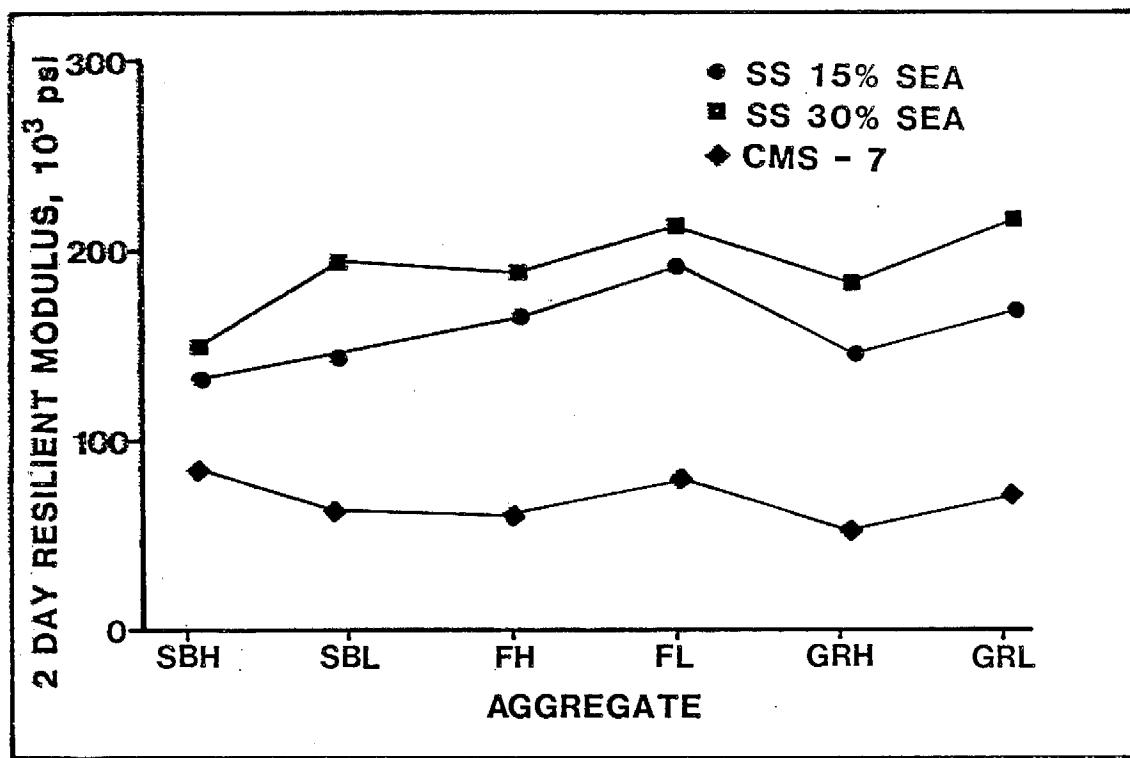


Figure D5. 2 Day Resilient Modulus

<u><b>SAN BERNARDINO</b></u>		<u><b>FRESNO</b></u>		<u><b>GRANITEROCK</b></u>	
<u><b>HIGH</b></u>	<u><b>LOW</b></u>	<u><b>HIGH</b></u>	<u><b>LOW</b></u>	<u><b>HIGH</b></u>	<u><b>LOW</b></u>
SS-30% 149	SS-30% 194	SS-30% 186	SS-30% 207	SS-30% 176	SS-30% 211
SS-15% 132	SS-15% 140	SS-15% 168	SS-15% 191	SS-15% 135	SS-15% 162
CMS-7 81	CMS-7 52	CMS-7 49	CMS-7 75	CMS-7 42	CMS-7 60

Note: Values with a common vertical line are not statistically different.

Figure D6. Newman-Keuls Ranking, 2 Day Resilient Modulus,  $10^3$  psi

Table D7. Full Cure Resilient Modulus at Design  
Residue Content,  $10^3$  psi

		EMULSION		QUALITY LEVEL		AGGREGATE	
		SAN BERNARDINO		FRESNO		GRANITEROCK	
		HIGH	LOW	HIGH	LOW	HIGH	LOW
SS 15%	D ATA	325	310	390	319	272	302
	X	271	260	340	348	367	356
	S	293	285	365	334	320	329
	CV	38	35	35	21	67	38
SS 30%	D ATA	12.8	12.4	9.7	6.2	21.0	11.6
	X	282	337	303	362	318	289
	S	310	255	374	307	308	329
	CV	20	58	50	39	7	28
SEA CM S 7	D ATA	6.7	19.6	14.8	11.6	2.3	9.2
	X	296	296	339	335	313	309
	S	20	58	50	39	7	28
	CV	6.7	19.6	14.8	11.6	2.3	9.2
C M S 7	D ATA	78	110	75	110	80	110
	X	64	95	73	135	90	135
	S	71	103	74	123	85	123
	CV	10	11	1	18	7	18
	D ATA	13.9	10.4	1.9	14.4	8.3	14.4

Table D8. ANOVA Summary, Full Cure Resilient Modulus

ANOVA						
SOURCE	DF	SS	MS	F	F.05	F.01
E	2	393988.3888889	196994.1944445	1.78.4233024	.3.57	.6.05
A	2	8135.7222223	4058.3611112	3.5757743	3.57	6.05
D	1	616.6944445	616.6944445	.5585579	4.43	8.33
EA	4	2549.4444444	637.3611111	.5772263	2.95	4.61
ED	2	4415.0555555	2207.5277778	1.9994213	3.57	6.05
AD	2	170.0555555	85.0277778	.0770121	3.57	6.05
EDA	4	832.4444445	.208.3111111	.1284922	2.95	4.61
ERBD	18	19873.5000000	1104.0833333			
TOTAL	35	430562.3055556				

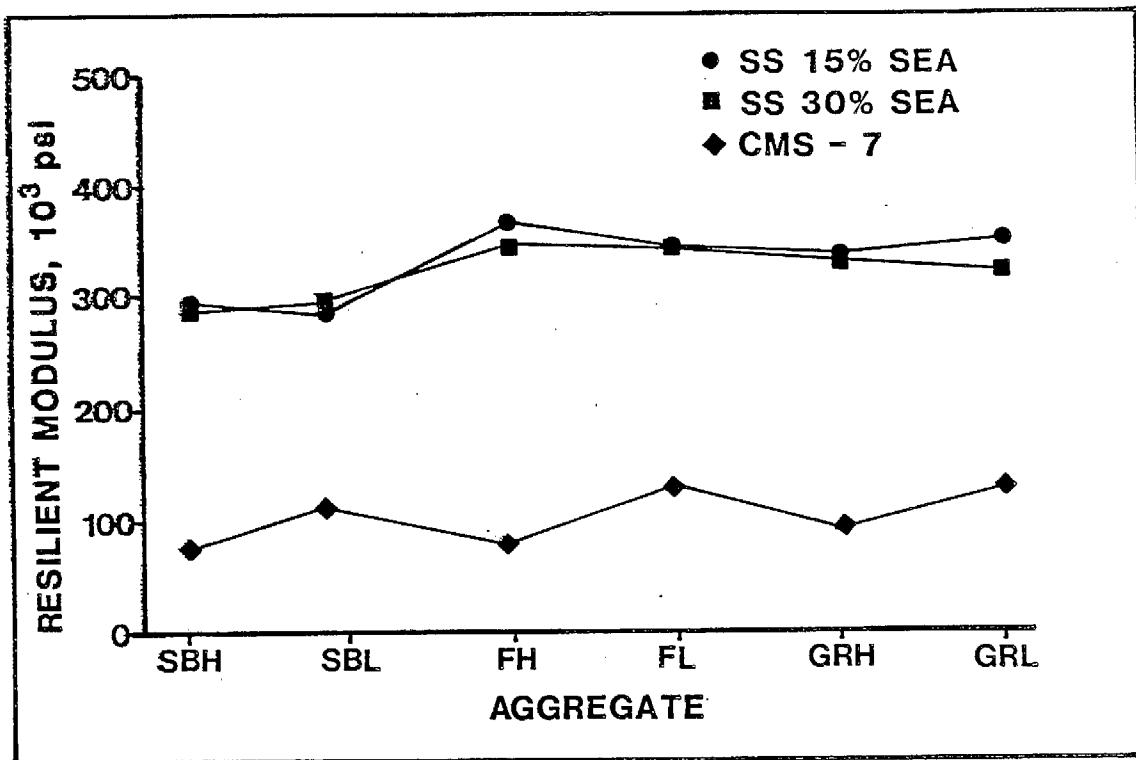


Figure D7. Full Cure Resilient Modulus at Design Residue Content

<u>SAN BERNARDINO</u>		<u>FRESNO</u>		<u>GRANITEROCK</u>	
<u>HIGH</u>	<u>LOW</u>	<u>HIGH</u>	<u>LOW</u>	<u>HIGH</u>	<u>LOW</u>
SS-15% 298	SS-30% 295	SS-15% 365	SS-30% 335	SS-15% 320	SS-15% 329
SS-30% 296	SS-15% 295	SS-30% 339	SS-15% 334	SS-30% 313	SS-30% 309
CMS-7 71	CMS-7 103	CMS-7 74	CMS-7 123	CMS-7 85	CMS-7 123

Note: Values with a common vertical line are not statistically different.

Figure D8. Newman-Keuls Ranking, Full Cure Resilient Modulus, 10<sup>3</sup> psi

Table D9. Density at Design Residue Content, pcf

		EMULSION						
		QUALITY LEVEL						
		AGGREGATE						
		SAN BERNARDINO		FRESNO				
		HIGH	LOW	HIGH	LOW			
15%	SS	D A T A	134.6 135.5	133.8 133.5	134.7 135.0	133.8 133.3	152.3 151.3	150.0 149.7
	SEA	X S CV	135.1 0.7 0.5	133.7 0.2 0.2	134.9 0.2 0.2	133.6 0.4 0.3	151.8 0.7 0.5	149.9 0.2 0.1
	SS	D A T A	136.2 137.1	135.2 135.5	137.0 136.1	135.5 135.4	154.5 155.0	152.0 152.5
	SEA	X S CV	136.7 0.6 0.5	135.4 0.2 0.2	136.6 0.6 0.5	135.5 0.1 0.1	154.8 0.4 0.2	152.3 0.4 0.2
	C	D A T A	137.3 138.5	137.5 137.5	138.0 137.9	137.0 136.0	153.7 153.5	154.3 154.5
	S	X S CV	137.9 0.9 0.6	137.5 0.0 0.0	138.0 0.1 0.1	136.5 0.7 0.5	153.6 0.1 0.1	154.4 0.1 0.1
7	M							

Table D10. ANOVA Summary, Density

ANOVA						
SOURCE	DF	SS	MS	F	F.05	F.01
E	2	62.0738889	31.0369445	153.5905090	3.57	6.05
A	2	2273.9048889	1136.9544445	5630.0357534	3.57	6.05
G	1	12.6025000	12.6025000	52.4057772	4.43	8.33
EM	1	1.2777778	.4694445	2.3246218	2.95	4.61
ED	2	3.1316667	1.5558333	7.7537828	3.57	6.05
EG	2	.0865667	.0433334	.2145806	3.57	6.05
EGD	4	3.8266666	.9556667	4.7372764	2.95	4.61
ERROR	15	3.6350000	.2019444			
TOTAL	35	2361.1430556				

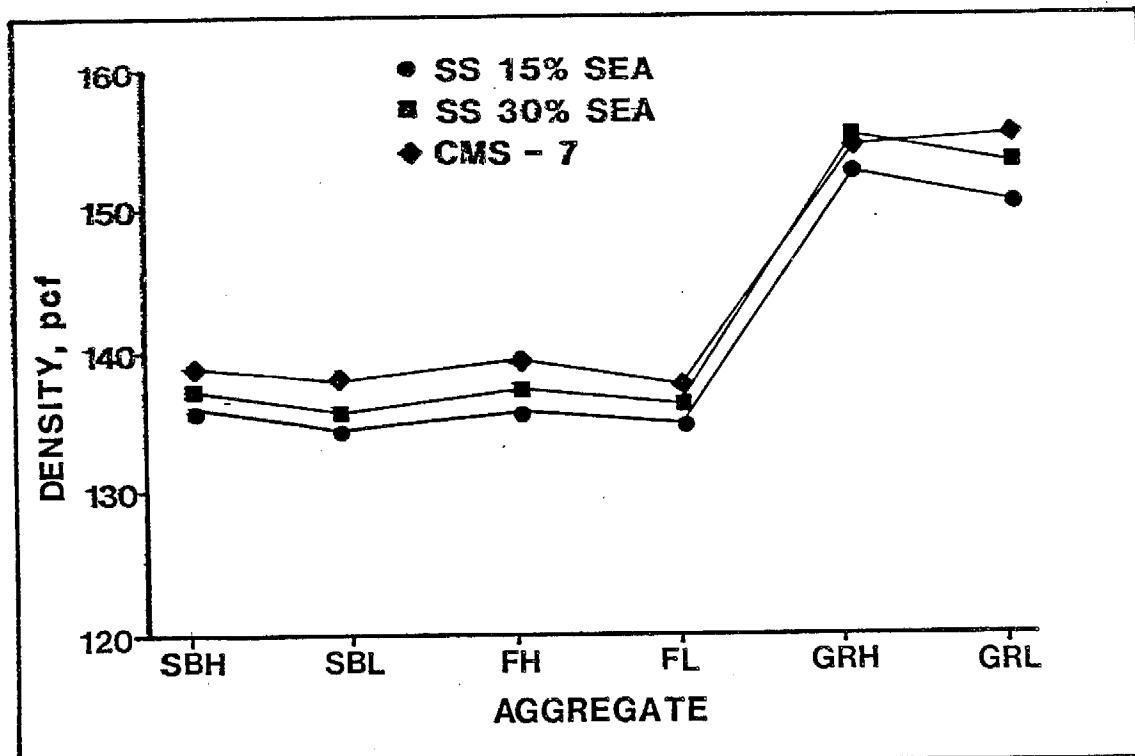


Figure D9. Density at Design Residue Content

<u>SAN BERNARDINO</u>		<u>FRESNO</u>		<u>GRANITEROCK</u>	
<u>HIGH</u>	<u>LOW</u>	<u>HIGH</u>	<u>LOW</u>	<u>HIGH</u>	<u>LOW</u>
CMS-7 137.9	CMS-7 137.5	CMS-7 138.0	CMS-7 136.5	SS-30% 154.8	CMS-7 154.4
SS-30% 136.7	SS-30% 135.4	SS-30% 136.6	SS-30% 135.5	CMS-7 153.6	SS-30% 152.3
SS-15% 135.1	SS-15% 133.7	SS-15% 134.9	SS-15% 133.6	SS-15% 151.8	SS-15% 149.9

Note: Values with a common vertical line are not statistically different.

Figure D10. Newman-Keuls Ranking, Density, pcf

Table D11. Air Voids at Design Residue Content, %

		EMULSION		QUALITY LEVEL		AGGREGATE	
		SAN BERNARDINO		FRESNO		GRANITEROCK	
		HIGH	LOW	HIGH	LOW	HIGH	LOW
15%	SS DATA	10.7 9.5	9.9 10.3	9.1 9.9	7.9 9.9	8.0 8.3	8.5 8.4
	X SEA s	10.1 0.9	10.1 0.3	9.5 0.6	8.9 1.4	8.2 0.2	8.5 0.1
	CV	8.4	2.8	6.0	15.9	2.6	0.8
	SS DATA	9.0 9.3	9.2 8.5	9.2 9.6	8.6 8.4	6.6 6.7	7.4 7.3
	X SEA s	9.2 0.2	8.9 0.5	9.4 0.3	8.5 0.1	6.7 0.1	7.4 0.1
	CV	2.3	5.6	3.0	1.7	1.1	1.0
30%	CM DATA	7.7 7.3	6.2 6.1	7.3 6.2	6.3 7.1	7.1 6.5	4.8 5.5
	X S	7.5 0.3	6.2 0.1	6.8 0.8	6.7 0.6	6.8 0.4	5.2 0.5
	CV	3.8	1.2	11.5	9.6	6.2	9.6

Table D12. ANOVA Summary, Air Voids

ANOVA						
SOURCE	DF	SS	MS	F	F.05	F.01
E	2	45.1816666	22.5908333	81.2457541	3.57	6.05
A	2	15.8606000	7.9300000	28.5194805	3.57	6.05
O	1	1.6869444	1.6469444	5.9230768	4.43	8.33
SE	4	2.7532334	.5883334	2.4755245	2.95	4.61
EQ	2	1.5672223	.7836112	2.8181820	3.57	6.05
RQ	2	.2022223	.1011112	.3535365	3.57	6.05
EAQ	4	2.9711110	.7427778	2.6713286	2.95	4.61
ERROR	18	5.3050000	.2790556			
TOTAL	35	75.1875000				

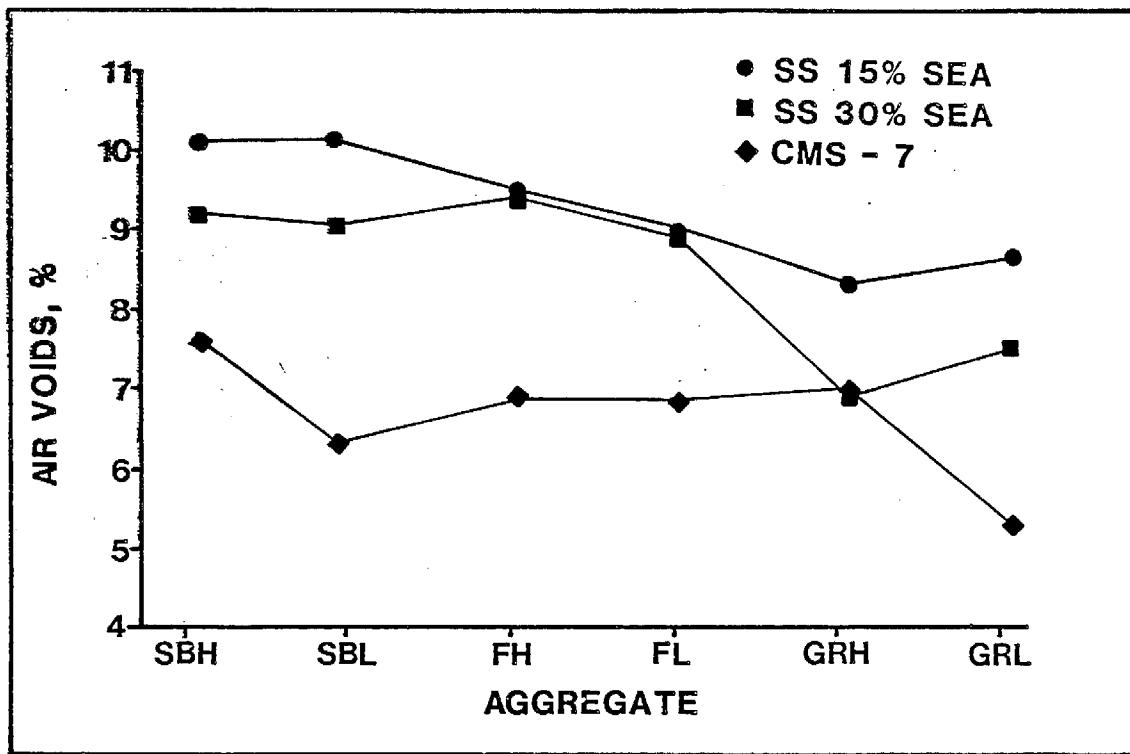


Figure D11. Air Voids at Design Residue Content

<u>SAN BERNARDINO</u>		<u>FRESNO</u>		<u>GRANITEROCK</u>	
<u>HIGH</u>	<u>LOW</u>	<u>HIGH</u>	<u>LOW</u>	<u>HIGH</u>	<u>LOW</u>
SS-15% 10.1	SS-15% 10.1	SS-15% 9.5	SS-15% 8.9	SS-15% 8.2	SS-15% 8.5
SS-30% 9.2	SS-30% 8.9	SS-30% 9.4	SS-30% 8.5	CMS-7 6.8	SS-30% 7.4
CMS-7 7.5	CMS-7 6.2	CMS-7 6.8	CMS-7 6.7	SS-30% 6.7	CMS-7 5.2

Note: Values with a common vertical line are not statistically different.

Figure D12. Newman-Keuls Ranking, Air Voids, %

Table D13. Stabilometer Value at Design Residue Content

		EMULSION						
		QUALITY LEVEL						
		AGGREGATE						
		SAN BERNARDINO		FRESNO				
		HIGH	LOW	HIGH	LOW			
15%	SS	D A T A	48.8 39.8	29.5 32.8	43.9 39.6	39.7 41.8	28.8 30.7	22.3 30.7
	SEA	X S CV	44.3 6.4 14.4	31.2 2.3 7.5	41.8 3.0 7.3	40.8 1.5 3.6	29.8 1.3 4.5	26.5 5.9 22.4
	SS	D A T A	40.0 40.3	36.7 28.3	34.2 41.1	39.2 26.2	31.0 32.4	29.2 23.6
30%	SEA	X S CV	40.2 0.2 0.5	32.5 5.9 18.3	37.7 4.9 13.0	32.7 9.2 28.1	31.7 1.0 3.1	26.4 4.0 15.0
	C M S	D A T A	23.5 23.5	13.0 12.0	21.3 23.3	15.0 20.0	35.0 35.0	25.0 25.0
	7	X S CV	23.5 0.0 0.0	12.5 0.7 5.7	22.3 1.4 6.3	17.5 3.5 20.2	35.0 0.0 0.0	25.0 0.0 0.0

Table D14. ANOVA Summary, Stabilometer Value

ANOVA						
SOURCE	DF	SS	MS	F	F.05	F.01
E	2	1175.8066666	587.9033333	39.2259711	3.57	6.05
A	2	55.8950000	27.9475000	1.9547552	3.57	6.05
C	1	414.8011111	414.8011111	27.5769841	4.43	8.33
EA	4	765.4183333	191.1045834	12.8178912	2.95	4.61
EC	2	14.8022223	7.4011111	.4938281	3.57	6.05
AC	2	75.5005556	37.7502778	2.5188309	3.57	6.05
EAC	4	34.5361110	8.6340278	.5760926	2.95	4.61
ERROR	18	269.7700000	14.9872222			
TOTAL	35	2909.5300000				

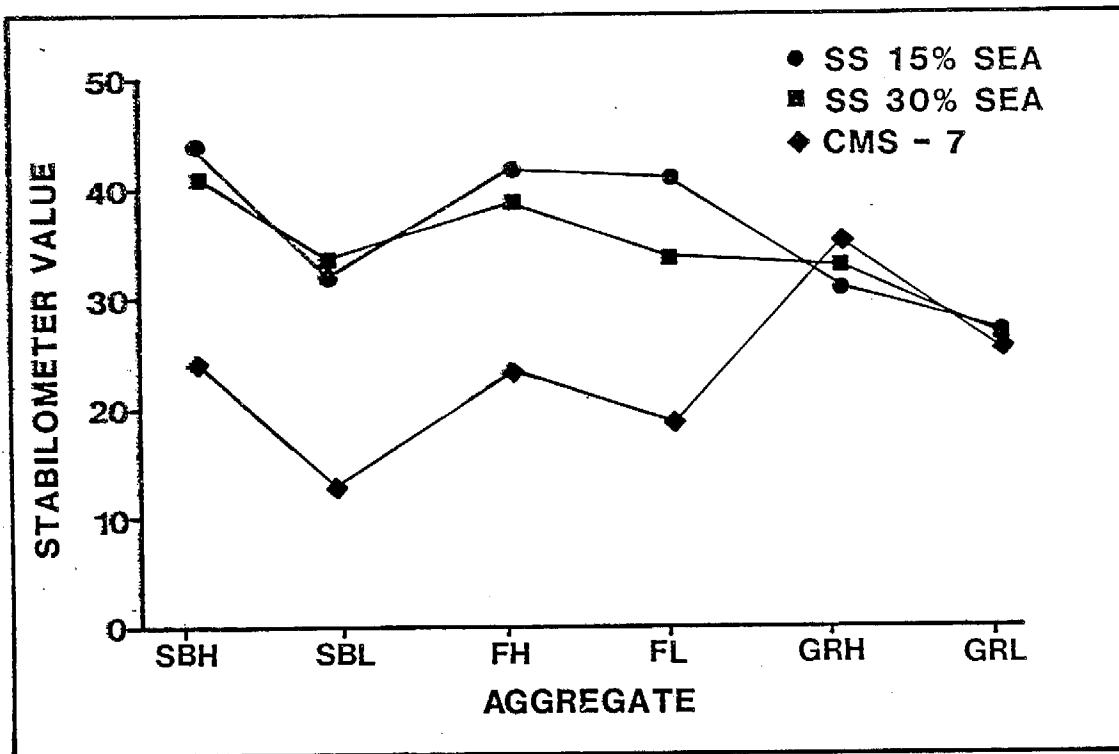


Figure D13. Stabilometer Value at Design Residue Content

<u>SAN BERNARDINO</u>		<u>FRESNO</u>		<u>GRANITEROCK</u>	
<u>HIGH</u>	<u>LOW</u>	<u>HIGH</u>	<u>LOW</u>	<u>HIGH</u>	<u>LOW</u>
SS-15% 44.3	SS-30% 32.5	SS-15% 41.8	SS-15% 40.8	CMS-7 35.0	SS-15% 26.5
SS-30% 40.2	SS-15% 31.2	SS-30% 37.7	SS-30% 32.7	SS-30% 31.7	SS-30% 26.4
CMS-7 23.5	CMS-7 12.5	CMS-7 22.3	CMS-7 17.5	SS-15% 29.8	CMS-7 25.0

Note: Values with a common vertical line are not statistically different.

Figure D14. Newman-Keuls Ranking, Stabilometer Value

Table D15. Cohesiometer Value at Design Residue Content

		EMULSION		QUALITY LEVEL		AGGREGATE	
		SAN BERNARDINO		FRESNO		GRANITEROCK	
		HIGH	LOW	HIGH	LOW	HIGH	LOW
15%	SS	D A T A	63 62	174 103	236 76	308 62	112 85
	SEA	X s CV	63 1.0 1.0	139 50 36.3	156 113 72.5	185 174 94.0	99 19 19.4
	SS	D A T A	229 306	266 187	78 130	260 136	157 212
	SEA	X s CV	268 55 204	227 56 24.7	104 37 35.4	198 88 44.3	185 39 21.1
	C M S 7	D A T A X s CV	80 82 81 1 1.8	190 180 185 7 3.8	122 192 157 50 31.5	245 235 240 7 3.0	130 120 125 7 5.7
							170 180 175 7 4.0

Table D16. ANOVA Summary, Cohesiometer Value

ANOVA							
SOURCE	DF	SS	MS	F	F.05	F.01	
E	2	.16712.7222222	8356.3611111	2.2567465	3.57	6.05	
A	2	1422.8888889	711.4444445	.1929864	3.57	6.05	
Q	1	26460.4444445	26460.4444445	7.1776602	4.43	8.33	
EA	4	.37580.7777778	.9395.1944444	2.5485405	2.95	4.61	
EQ	2	7245.3888889	3622.6988884	.9826921	3.57	6.05	
AQ	2	947.5555555	470.7777778	.1277032	3.57	6.05	
FAQ	4	13288.1111111	3322.0277778	.9011333	2.97	4.61	
ERROR	12	66357.0000000	3686.5000000				
TOTAL	35	173008.8888889					

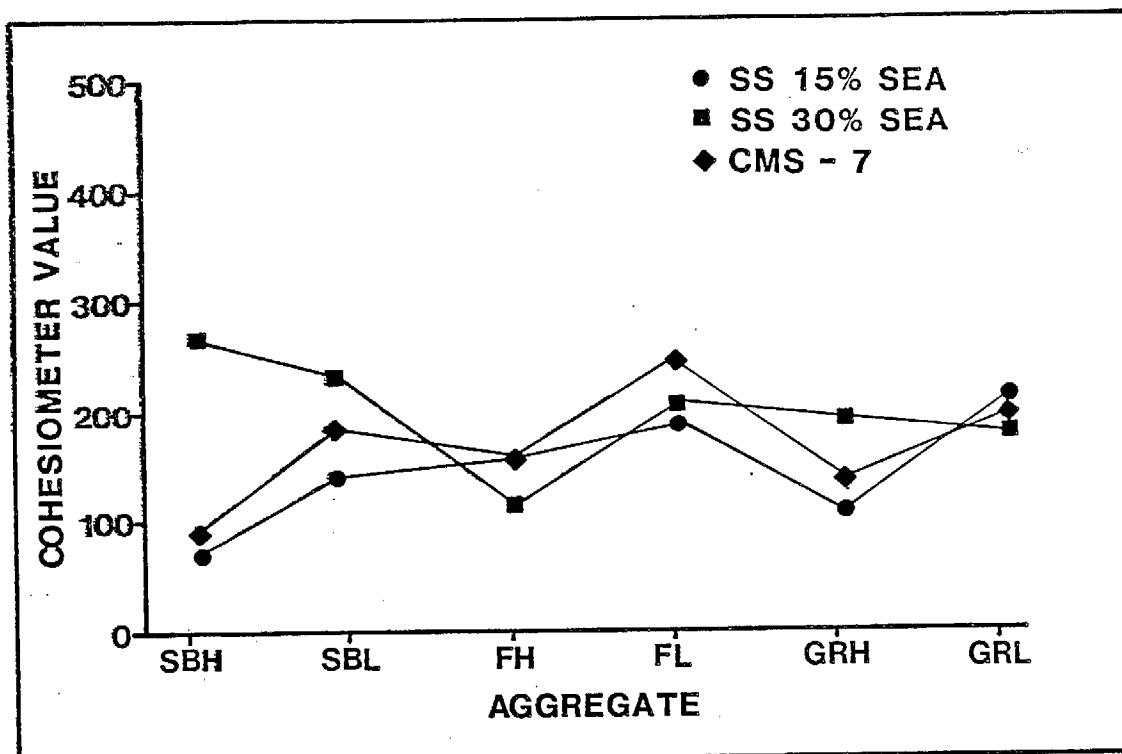


Figure D15. Cohesiometer Value at Design Residue Content

<u>SAN BERNARDINO</u>		<u>FRESNO</u>		<u>GRANITEROCK</u>	
<u>HIGH</u>	<u>LOW</u>	<u>HIGH</u>	<u>LOW</u>	<u>HIGH</u>	<u>LOW</u>
SS-30% 268	SS-30% 227	CMS-7 157	CMS-7 240	SS-30% 185	SS-15% 201
CMS-7 81	CMS-7 185	SS-15% 156	SS-30% 198	CMS-7 125	SS-30% 175
SS-15% 63	SS-15% 139	SS-30% 104	SS-15% 185	SS-15% 99	CMS-7 175

Note: Values with a common vertical line are not statistically different.

Figure D16. Newman-Keuls Ranking,  
Cohesiometer Value

Table D17. Swell at Design Residue Content, in.

		EMULSION		QUALITY LEVEL		AGGREGATE	
		SAN BERNARDINO		FRESNO		GRANITEROCK	
		HIGH	LOW	HIGH	LOW	HIGH	LOW
15%	SS	D A T X	.048 - .069 .048	.065 .006 .008	.005 .025 .045	.005 .004 .004	.005 .009 .014
	SEA	S CV	.000 .000	.068 .003	.006 .002	.035 .010	.004 .001
	SS	D A T A	.023 .023 .020	.063 .066 .055	.000 .000 .008	.031 .023 .028	.000 .000 .003
	SEA	X S CV	.022 .002 7.9	.061 .006 9.3	.003 .005 173.2	.027 .004 14.8	.001 .002 173.2
	C	D A T A	.000 .000 .000	.004 .002 .001	.000 .000 .000	.003 .000 .000	.000 .000 .000
	S	X S CV	.000 .000 .000	.002 .002 65.5	.000 .000 .000	.001 .002 173.2	.000 .000 .000
7	M						

Table D18. ANOVA Summary, Swell  
(✓ Transformed Data)

ANOVA						
SOURCE	DF	SS	MS	F	F.05	F.01
E	2	.1825326	.0912663	235.3471054	3.29	5.32
A	2	.1366452	.0683226	176.1825136	3.29	5.32
Q	1	.0368219	.0368219	94.9521081	4.14	7.46
EA	4	.0462787	.0115697	29.8345558	2.66	3.95
EQ	2	.0069036	.0034515	.8.9003553	3.29	5.32
AQ	2	.0150358	.0075179	19.3863914	3.29	5.32
ERQ	4	.0083986	.0020997	5.4143375	2.66	3.96
ERROR	36	.0139606	.0003878			
TOTAL	53	.4465764				

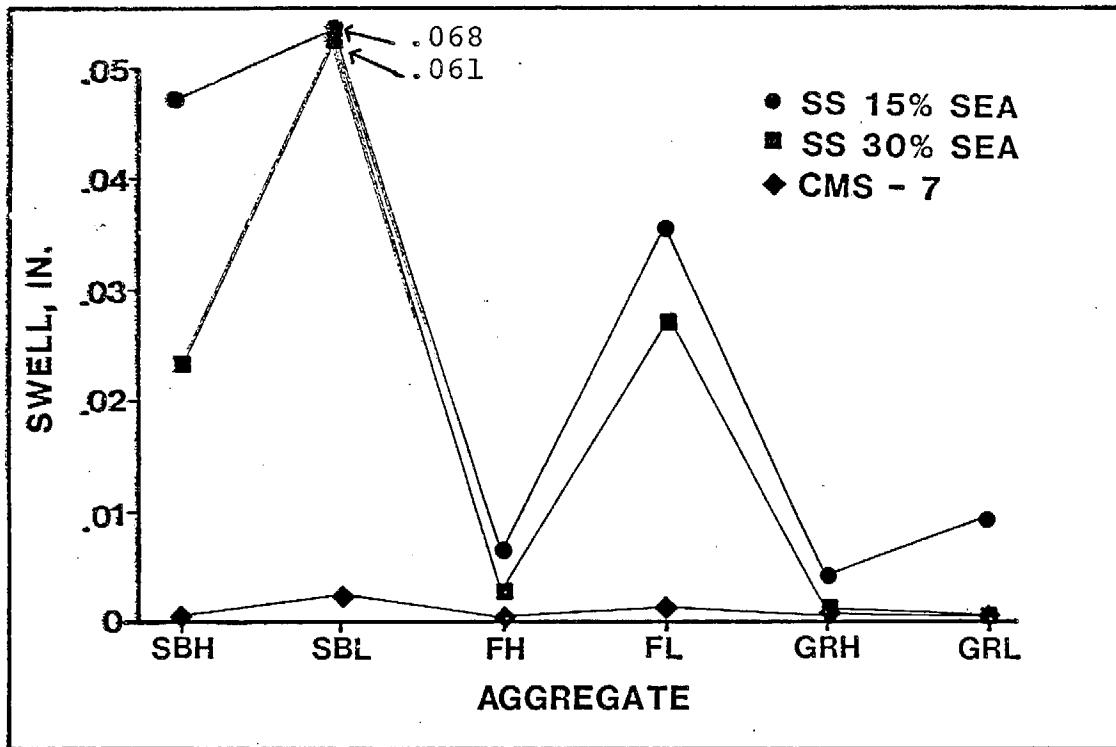


Figure D17. Swell at Design Residue Content

<u>SAN BERNARDINO</u>		<u>FRESNO</u>		<u>GRANITEROCK</u>	
<u>HIGH</u>	<u>LOW</u>	<u>HIGH</u>	<u>LOW</u>	<u>HIGH</u>	<u>LOW</u>
SS-15% .048	SS-15% .068	SS-15% .006	SS-15% .035	SS-15% .004	SS-15% .009
SS-30% .022	SS-30% .061	SS-30% .003	SS-30% .027	SS-30% .001	SS-30% .000
CMS-7 .000	CMS-7 .002	CMS-7 .000	CMS-7 .001	CMS-7 .000	CMS-7 .000

Note: Values with a common vertical line are not statistically different.

Figure D18. Newman-Keuls Ranking, Swell, in.

Table D19. MVS Conditioned Stabilometer Value at Design Residue Content

		EMULSION						
		QUALITY LEVEL						
		AGGREGATE						
		SAN BERNARDINO		FRESNO				
		HIGH	LOW	HIGH	LOW			
15%	SS	D A T A	15.6 11.5 13.9	4.8 6.0 4.8	17.5 20.1 17.0	22.9 11.7 13.2	21.0 22.8 21.2	12.5 12.0 13.0
	SEA	X s CV	13.7 2.1 15.1	5.2 0.7 13.3	18.2 1.7 9.2	20.0 3.0 14.8	21.7 1.0 4.6	12.5 0.5 4.0
	SS	D A T A	9.8 20.3 11.3	10.6 10.9 8.5	11.1 7.6 6.3	7.6 5.1 5.9	21.0 23.5 23.3	11.1 9.5 12.5
	SEA	X s CV	13.8 5.7 41.2	10.0 1.3 13.1	8.3 2.5 29.8	6.2 1.3 20.6	22.6 1.4 6.2	11.0 1.5 13.6
30%	C M S 7	D A T A X s CV	21.0 22.0 21.6 21.5 0.5 2.3	20.2 8.7 13.8 14.2 5.8 40.5	18.5 18.1 22.3 19.6 2.3 11.8	9.8 8.8 7.7 8.8 1.1 12.0	33.0 34.5 33.8 33.8 0.8 2.2	24.0 20.0 21.0 21.7 2.1 9.6

Table D20. ANOVA Summary, MVS Conditioned Stabilometer Value

ANOVA						
SOURCE	DF	SS	MS	F	F.05	F.01
E	2	591.9825926	295.9912963	39.0470758	3.29	5.32
A	2	690.0448148	345.0224074	45.5152441	3.29	5.32
Q	1	763.1296296	763.1296296	100.6718132	4.14	7.46
EA	4	403.1478074	100.7862519	13.2957688	2.66	3.96
EQ	2	46.9359259	23.0179529	3.0365222	3.29	5.32
AQ	2	83.8470370	41.9235185	5.5305370	3.29	5.32
EQQ	4	54.1074075	13.5268519	1.7844579	2.66	3.96
ERROR	36	272.8933333	7.5903704			
TOTAL	53	2905.1881381				

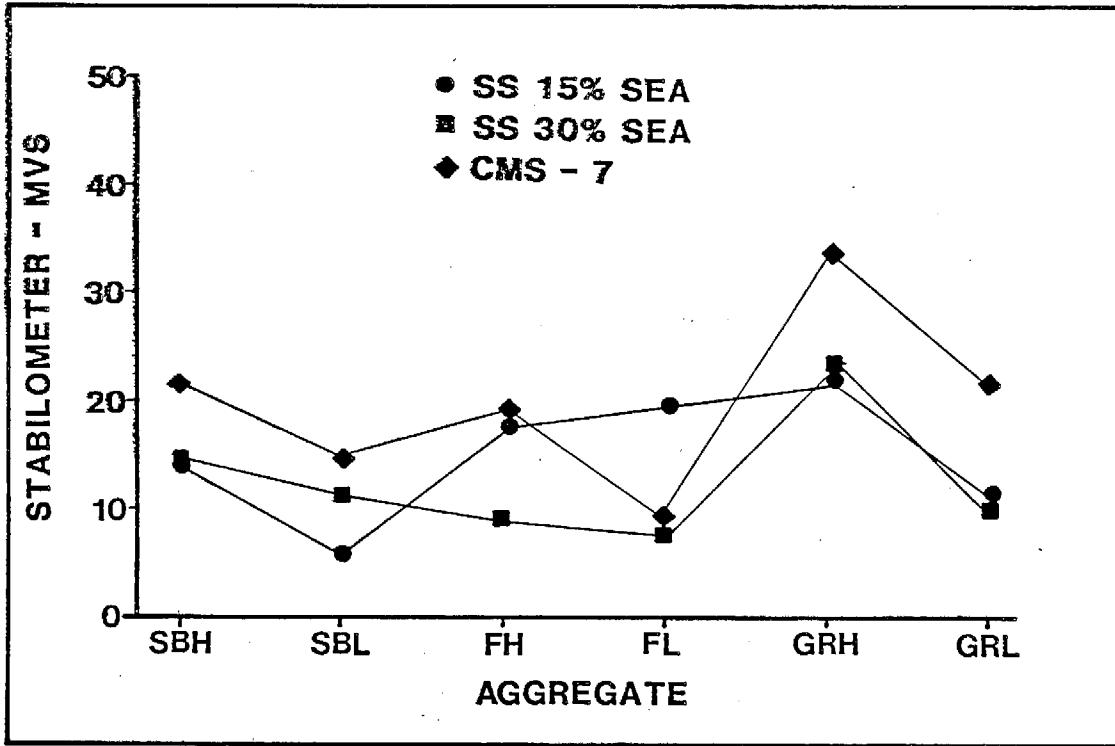


Figure D19. MVS Conditioned Stabilometer Value at Design Residue Content

<u><b>SAN BERNARDINO</b></u>		<u><b>FRESNO</b></u>		<u><b>GRANITEROCK</b></u>	
<u><b>HIGH</b></u>	<u><b>LOW</b></u>	<u><b>HIGH</b></u>	<u><b>LOW</b></u>	<u><b>HIGH</b></u>	<u><b>LOW</b></u>
CMS-7 21.5	CMS-7 14.2	CMS-7 19.6	SS-15% 20.0	CMS-7 33.8	CMS-7 21.7
SS-30% 13.8	SS-30% 10.0	SS-15% 18.2	CMS-7 8.8	SS-30% 22.6	SS-15% 12.5
SS-15% 13.7	SS-15% 5.2	SS-30% 8.3	SS-30% 6.2	SS-15% 21.7	SS-30% 11.0

Note: Values with a common vertical line are not statistically different.

Figure D20. Newman-Keuls Ranking, MVS Conditioned Stabilometer Value

Table D21. MVS Conditioned Cohesiometer Value at Design Residue Content

		EMULSION						
		QUALITY LEVEL						
		AGGREGATE						
		SAN BERNARDINO		FRESNO				
		HIGH	LOW	HIGH	LOW			
15%	SS	D A T A	103 TWT 117	TWT * TWT TWT	159 143 126	123 187 60	130 179 153	120 104 143
	SEA	$\bar{x}$ s CV	43 64 87.1	- - -	143 17 11.6	123 64 51.5	154 25 15.9	122 20 16.0
	SS	D A T A	139 88 104	98 91 -	114 116 69	TWT * TWT TWT	111 101 154	83 65 63
	SEA	$\bar{x}$ s CV	110 26 23.6	95 4 3.7	100 27 26.7	- - -	122 28 23.1	70 11 15.7
30%	C M S 7	D A T A	141 79 52	185 60 63	125 201 96	192 164 126	131 130 120	72 230 76
	SEA	$\bar{x}$ s CV	91 46 50.3	103 71 69.5	141 54 38.6	161 33 20.6	127 6 4.8	126 90 71.5

\* Too weak to test.

Table D22. ANOVA Summary, MVS Conditioned Cohesiometer Value

ANOVA							
SOURCE	DF	SS	MS	F	F:05	F:01	
E	2	19956.0370370	9978.0185185	5.2791162	3.29	5.32	
A	2	22308.9259259	11154.4629630	5.9015431	3.29	5.32	
Q	1	14210.6666666	14210.6666666	7.5185029	4.14	7.46	
EA	4	32876.7407808	8219.1851852	4.3485622	2.66	3.96	
EQ	2	13733.4444445	6866.7222223	3.6330084	3.29	5.32	
AQ	2	150.1111112	75.0555556	0.397130	3.29	5.32	
EMQ	4	5119.7777777	1279.9444444	0.5771861	2.66	3.96	
ERROR	36	58043.3333333	1611.03925926				
TOTAL	53	175399.0370370					

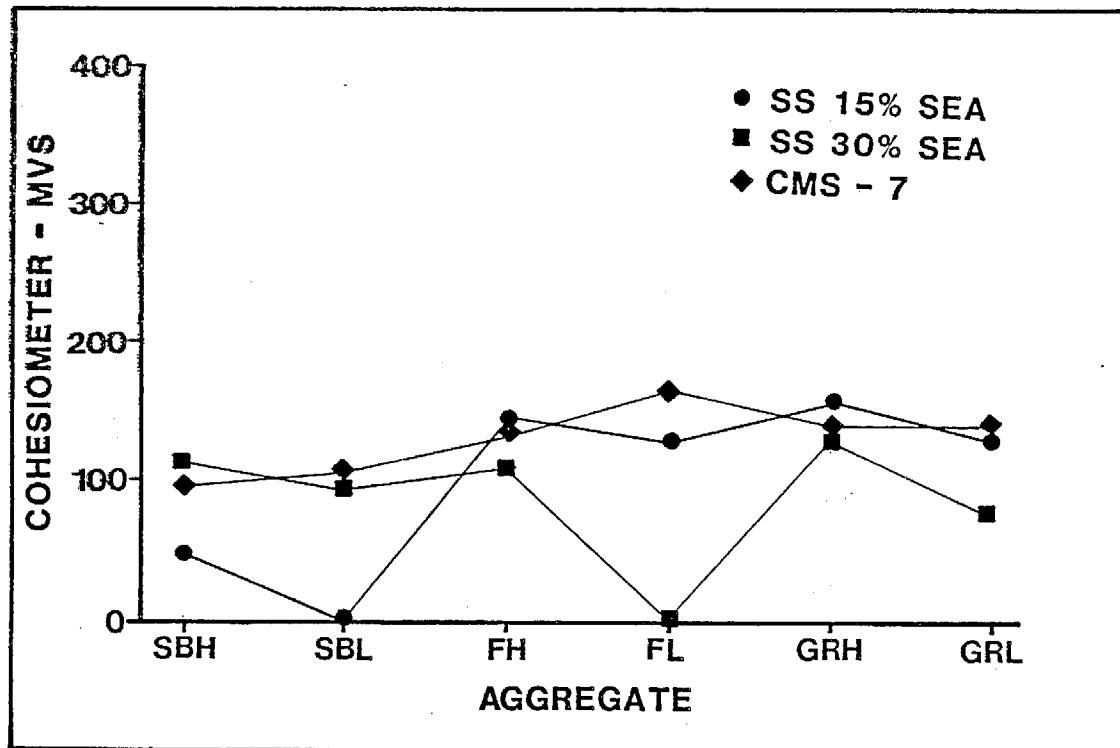


Figure D21. MVS Conditioned Cohesiometer Value at Design Residue Content

<u>SAN BERNARDINO</u>		<u>FRESNO</u>		<u>GRANITEROCK</u>	
<u>HIGH</u>	<u>LOW</u>	<u>HIGH</u>	<u>LOW</u>	<u>HIGH</u>	<u>LOW</u>
SS-30% 110	CMS-7 103	SS-15% 143	CMS-7 161	SS-15% 154	CMS-7 126
CMS-7 91	SS-30% 95	CMS-7 141	SS-15% 123	CMS-7 127	SS-15% 122
SS-15% 93	SS-15% TWT	SS-30% 100	SS-30% TWT	SS-30% 122	SS-30% 70

Note: Values with a common vertical line are not statistically different.

Figure D22. Newman-Keuls Ranking, MVS Conditioned Cohesiometer Value

Table D23. Surface Abrasion at Design Residue Content, grams

		EMULSION		QUALITY LEVEL		AGGREGATE	
		SAN BERNARDINO		FRESNO		GRANITEROCK	
		HIGH	LOW	HIGH	LOW	HIGH	LOW
15%	SS DATA	** * **	* * *	97.9 114.3 104.7	** ** *	71.5 56.9 59.9	128.5 135.3 149.3
	X SS	-	-	105.6	-	62.8	137.7
	S CV	-	-	8.2	-	7.7	10.6
	SEA SS	-	-	7.8	-	12.3	7.7
	X S	*	*	98.7* 90.7*	147.4 153.6 144.7	54.8 43.3 61.5	62.7 72.2 63.4
	CV	-	-	94.7	148.6	53.2	66.1
30%	SS DATA	*	*	5.7	4.6	9.2	5.3
	X S	-	-	6.0	3.1	17.3	8.0
	CV	-	-				
	C DAT	64.2 62.0 77.4	10.2 42.6 66.2	59.7 36.9 47.0	58.8 60.1 29.0	30.1 26.3 39.3	23.8 28.4 22.7
	M X	67.9	39.7	47.9	49.3	31.9	25.0
	S s	8.3	28.1	11.4	17.6	6.7	3.0
7	CV	12.3	70.9	23.9	35.7	21.0	12.1

\* Specimen swelled during soak, could not be tested.

\*\* Specimen disintegrated during testing.

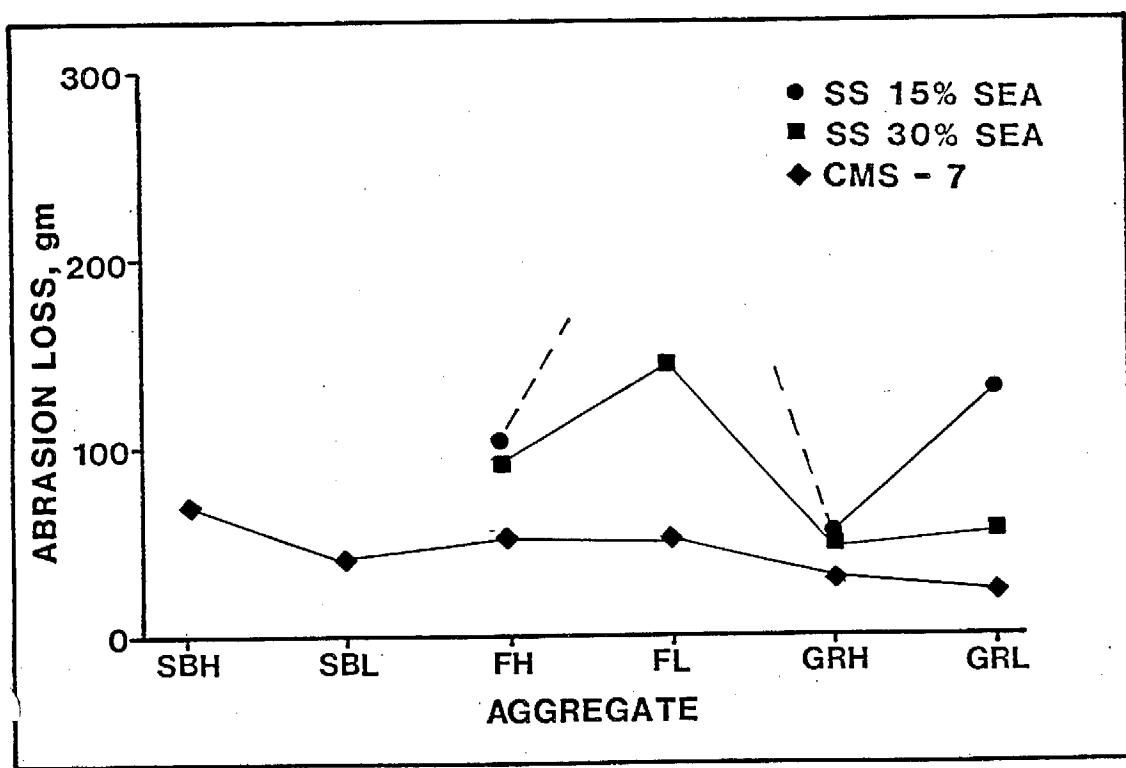


Figure D23. Surface Abrasion at Design Residue Content

**APPENDIX E**

**FULL DEPTH PAVEMENT  
STRUCTURAL DESIGNS**

Table El

Thickness\*  $T_i$ , in Inches to Satisfy  
Tensile Strain Requirements (Reference 3)

Subgrade Modulus, psi	3,000				6,000				12,000				30,000			
	<40	40-55	55-65	>65	<40	40-55	55-65	>65	<40	40-55	55-65	>65	<40	40-55	55-65	>65
<i>Average Annual Air Temperature, °F</i>																
<i>M<sub>R</sub>, psi</i> = 50,000	4.9	6.6	7.8	9.1	3.7	5.0	5.8	6.6	2	2.6	2.8	2.9	2	2	2	2
Traffic, EAL = 10 <sup>4</sup>	100,000	3.7	5.3	6.2	7.2	2.7	4.0	4.7	5.3	2	2.1	2.5	2.6	2	2	2
	300,000	2.1	3.4	4.3	5.1	2	2.8	3.1	3.8	2	2	2	2	2	2	2
	600,000	2	2.4	3.2	3.9	2	2.2	2.8	2	2	2	2	2	2	2	2
	900,000	2	2	2.6	3.3	2	2	2.2	2	2	2	2	2	2	2	2
<i>M<sub>R</sub>, psi</i> = 10 <sup>5</sup>																
	NR, psi	6.3	11.5	13.9	16.5	7.0	9.7	11.2	12.7	5.4	7.3	8.3	9.3	2.3	2.7	2.8
	120,000	6.3	9.0	10.8	12.9	5.4	7.6	9.1	10.5	4.2	5.8	6.9	7.8	2	2.5	2.7
	300,000	4.0	6.8	7.3	8.7	3.3	5.1	6.0	7.3	2.4	3.9	4.8	5.6	2	2.0	2.2
	600,000	2.8	4.5	5.5	6.7	2.1	3.7	4.7	5.6	2	2.7	3.6	4.4	2	2	2
	900,000	2.1	3.7	4.7	5.7	2	3.0	3.9	4.8	2	2.1	2.9	3.7	2	2	2
<i>M<sub>R</sub>, psi</i> = 10 <sup>6</sup>																
	NR, psi	13.0	18.1	21.6	24	11.6	16.1	18.7	21.3	9.8	13.1	15.1	17.2	6.8	8.6	9.3
	100,000	9.8	14.3	17.1	20.3	8.8	12.6	15.2	17.6	7.5	10.6	12.5	14.2	5.2	7.3	8.2
	300,000	6.0	9.1	11.3	13.9	5.5	8.2	10.1	12.2	4.7	6.9	8.6	10.2	3.1	4.9	5.9
	600,000	4.6	6.8	8.6	10.6	4.0	6.0	7.6	9.4	3.3	5.2	6.4	7.9	2	3.5	5.4
	900,000	3.7	5.6	7.2	8.9	3.2	5.1	6.3	8.0	2.4	4.3	5.4	6.7	2	2.8	4.6
<i>M<sub>R</sub>, psi</i> = 10 <sup>7</sup>																
	NR, psi	19.2	24	24	24	17.8	23.9	24	24	15.6	20.5	23.5	24	12.1	15.3	16.5
	100,000	14.5	21.0	24	24	13.5	19.3	22.8	24	11.9	16.8	19.5	22.2	9.5	12.9	15.7
	300,000	8.8	13.6	16.7	20.5	8.3	12.5	15.6	18.6	7.4	11.1	13.8	16.4	5.8	8.8	12.4
	600,000	6.4	10.0	12.5	15.6	5.9	9.2	11.6	14.5	5.3	8.2	10.4	12.8	4.1	6.5	10.0
	900,000	5.3	8.2	10.5	13.2	5.0	7.7	9.7	12.1	4.4	6.8	8.6	10.8	3.3	5.3	8.5

\* For asphalt volume,  $V_b = 11\%$  are air voids,  $V_a = 5\%$ .  
Use Figure El to correct thickness of other values of  $V_b$  and  $V_a$ .

Table E2

Thickness,  $T_s$ , in Inches to Satisfy  
Subgrade Strain Requirements (Reference 3)

Subgrade Modulus, psi	3,000			6,000			12,000			30,000		
	<40	40-55	55-65	>65	<40	40-55	55-65	>65	<40	40-55	55-65	>65
<u>Average Annual Air Temperature, °F</u>												
<u>Traffic, EAL = 10<sup>4</sup></u>	5.5	8.3	10.8	11.5	4.6	7.0	8.3	9.3	3.0	5.4	6.2	6.9
MR, psi = 50,000	5.5	6.0	7.3	8.2	4.6	5.0	6.1	7.0	3.0	3.4	4.6	5.3
100,000	5.5	5.5	5.5	5.5	4.6	4.6	4.6	4.6	3.0	3.0	3.0	3.0
300,000	5.5	5.5	5.5	5.5	4.6	4.6	4.6	4.6	3.0	3.0	3.0	3.0
600,000	5.5	5.5	5.5	5.5	4.6	4.6	4.6	4.6	3.0	3.0	3.0	3.0
900,000	5.5	5.5	5.5	5.5	4.6	4.6	4.6	4.6	3.0	3.0	3.0	3.0
<u>Traffic, EAL = 10<sup>5</sup></u>	8.1	12.1	14.5	16.5	6.9	10.3	12.4	13.9	5.5	8.3	9.5	10.6
MR, psi = 50,000	8.1	8.7	10.6	12.0	6.9	7.4	9.1	10.2	5.5	6.0	7.2	8.2
100,000	8.1	8.1	8.1	8.1	6.9	6.9	6.9	6.9	5.5	5.5	5.5	5.5
300,000	8.1	8.1	8.1	8.1	6.9	6.9	6.9	6.9	5.5	5.5	5.5	5.5
600,000	8.1	8.1	8.1	8.1	6.9	6.9	6.9	6.9	5.5	5.5	5.5	5.5
900,000	8.1	8.1	8.1	8.1	6.9	6.9	6.9	6.9	5.5	5.5	5.5	5.5
<u>Traffic, EAL = 10<sup>6</sup></u>	11.5	16.8	20.1	22.4	9.8	15.0	17.3	19.3	8.3	12.2	14.4	15.8
MR, psi = 50,000	11.5	12.3	14.8	16.5	9.8	10.8	13.0	14.7	8.3	9.0	10.8	12.1
100,000	11.5	11.5	11.5	11.5	9.8	9.8	9.8	9.8	8.3	8.3	8.3	8.3
300,000	11.5	11.5	11.5	11.5	9.8	9.8	9.8	9.8	8.3	8.3	8.3	8.3
600,000	11.5	11.5	11.5	11.5	9.8	9.8	9.8	9.8	8.3	8.3	8.3	8.3
900,000	11.5	11.5	11.5	11.5	9.8	9.8	9.8	9.8	8.3	8.3	8.3	8.3
<u>Traffic, EAL = 10<sup>7</sup></u>	15.5	22.6	24	24	13.6	20.4	23.9	24	12.0	17.5	20.5	22.6
MR, psi = 50,000	15.5	16.5	19.9	22.2	13.6	15.0	17.9	19.9	12.0	13.0	15.5	17.2
100,000	15.5	15.5	15.5	15.5	13.6	13.6	13.6	13.6	12.0	12.0	12.0	12.0
300,000	15.5	15.5	15.5	15.5	13.6	13.6	13.6	13.6	12.0	12.0	12.0	12.0
600,000	15.5	15.5	15.5	15.5	13.6	13.6	13.6	13.6	12.0	12.0	12.0	12.0
900,000	15.5	15.5	15.5	15.5	13.6	13.6	13.6	13.6	12.0	12.0	12.0	12.0

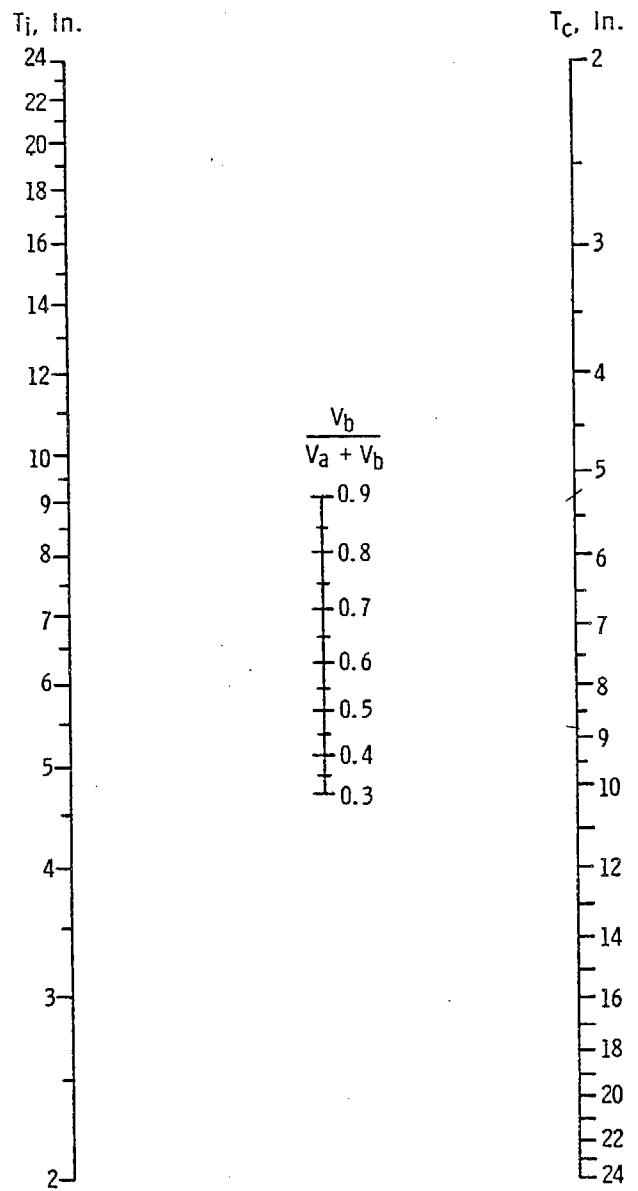


Figure E1. Correction of Pavement Design Thickness for Air Voids and Asphalt Content of Mix (Reference 3)

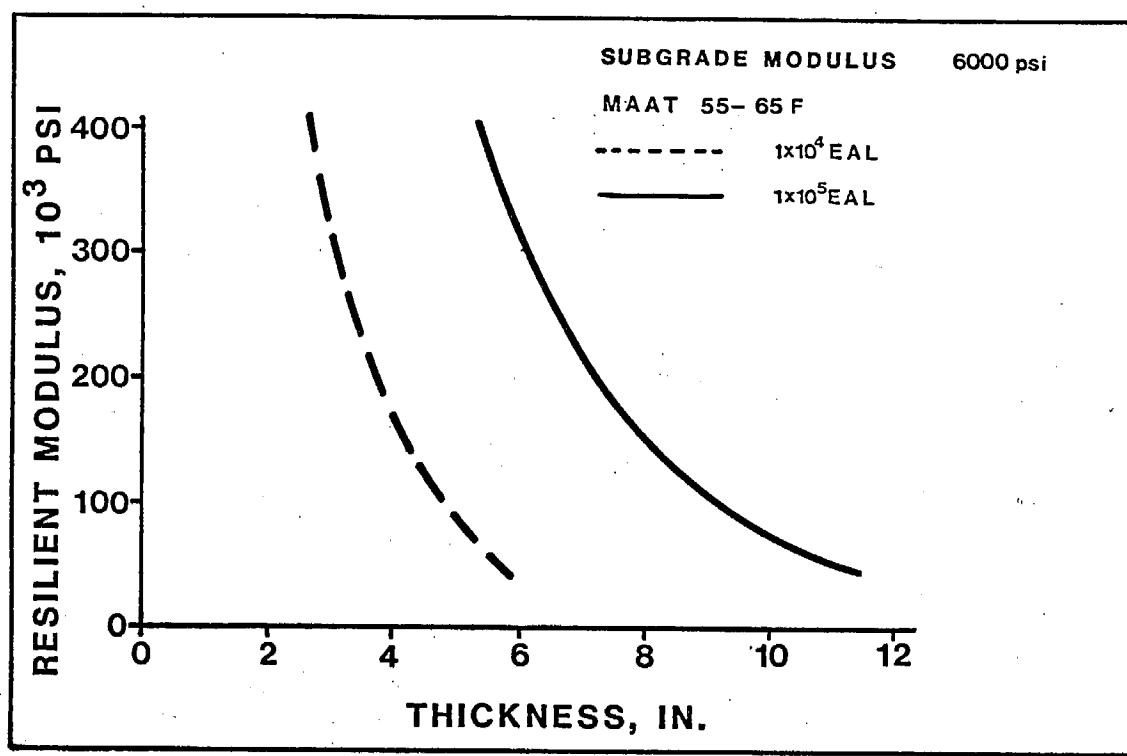


Figure E2. Thickness For Tensile Strain Requirement,  
 $E_s = 6000$  psi, MAAT = 55-65F

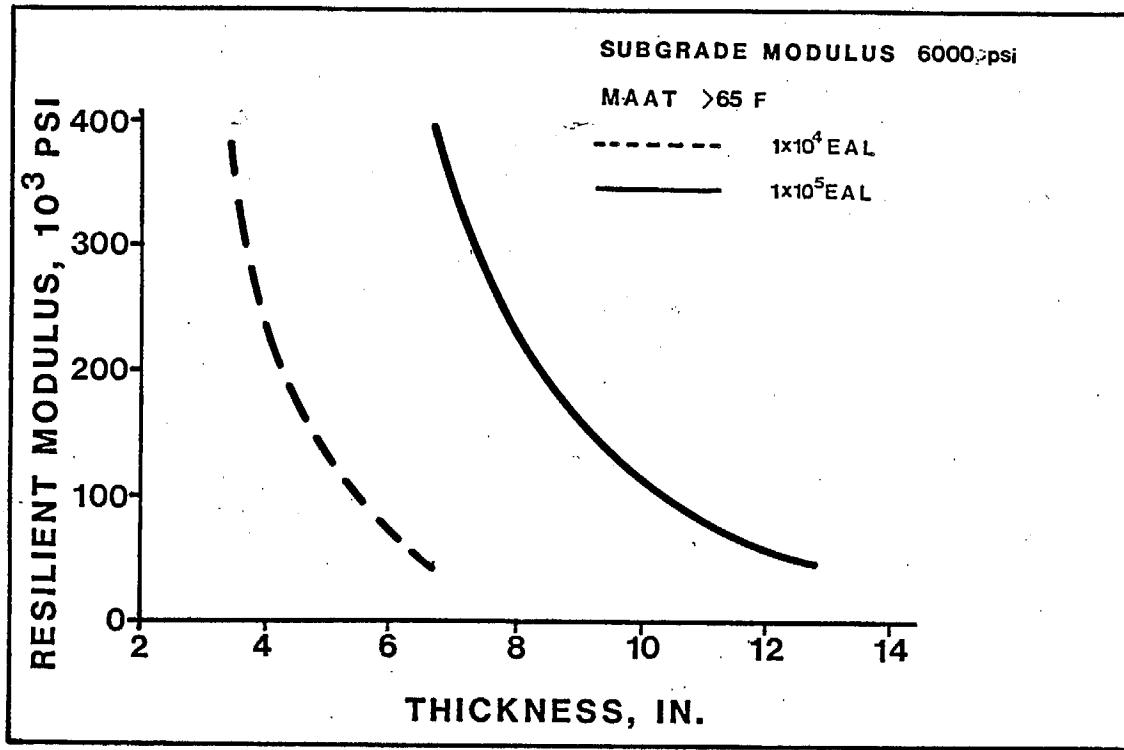


Figure E3. Thickness For Tensile Strain Requirement,  
 $E_s = 6000$  psi, MAAT = > 65F

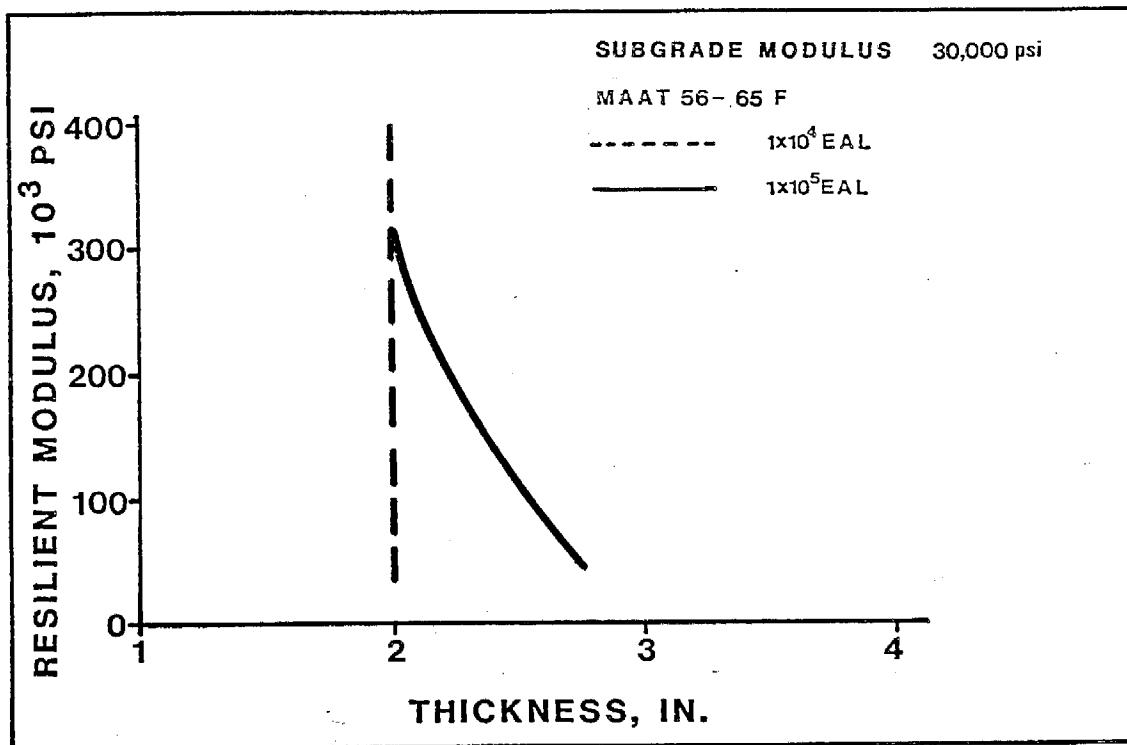


Figure E4. Thickness For Tensile Strain Requirement,  
 $E_s = 30,000$  psi, MAAT = 55-65F

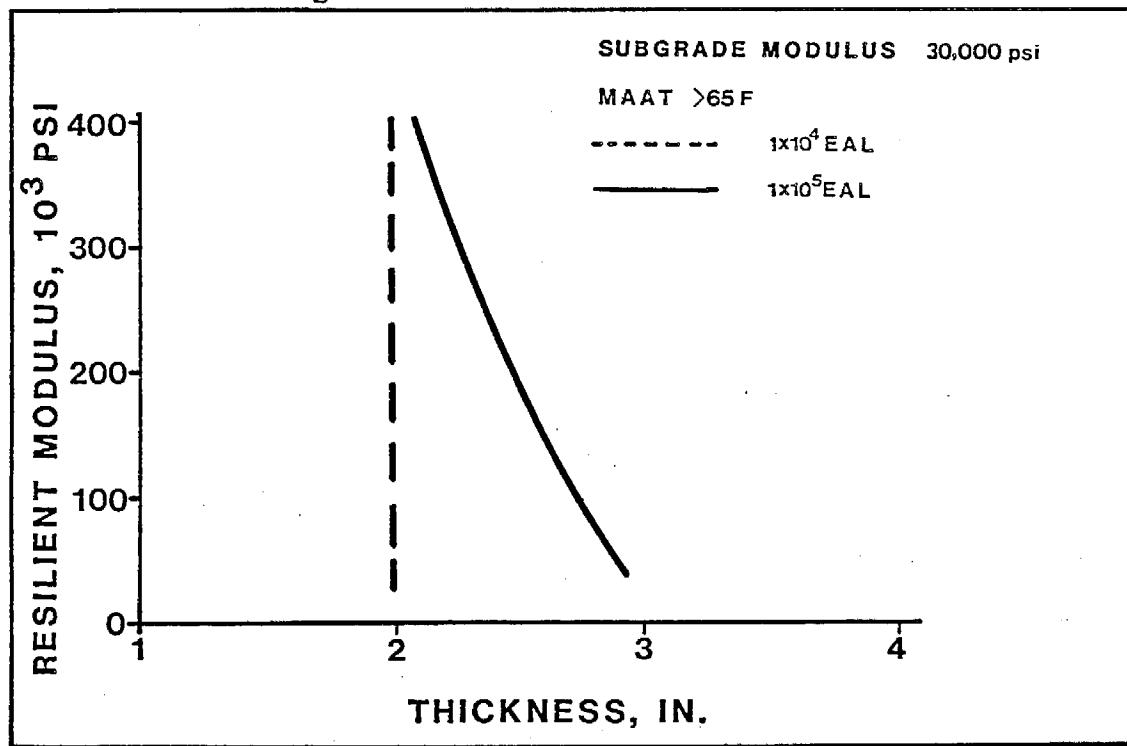


Figure E5. Thickness For Tensile Strain Requirement,  
 $E_s = 30,000$  psi, MAAT = > 65F

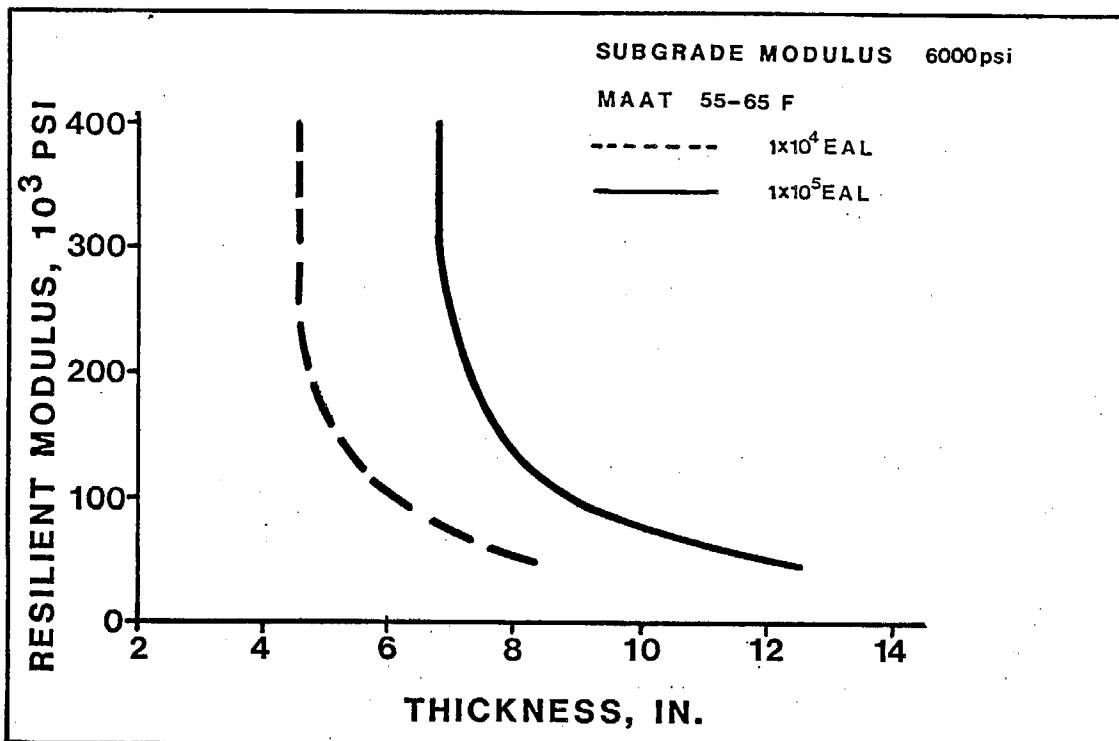


Figure E6. Thickness For Subgrade Strain Requirement,  
 $E_s = 6000$  psi, MAAT = 55-65F

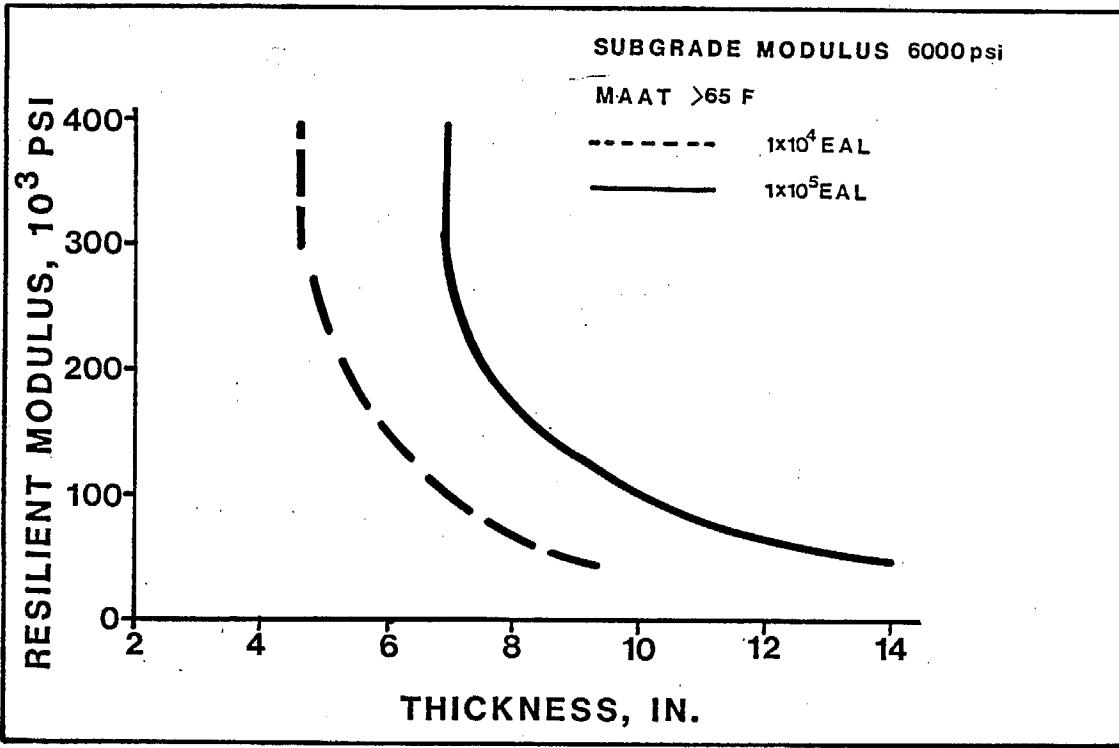


Figure E7. Thickness For Subgrade Strain Requirement,  
 $E_s = 6000$  psi, MAAT = >65F

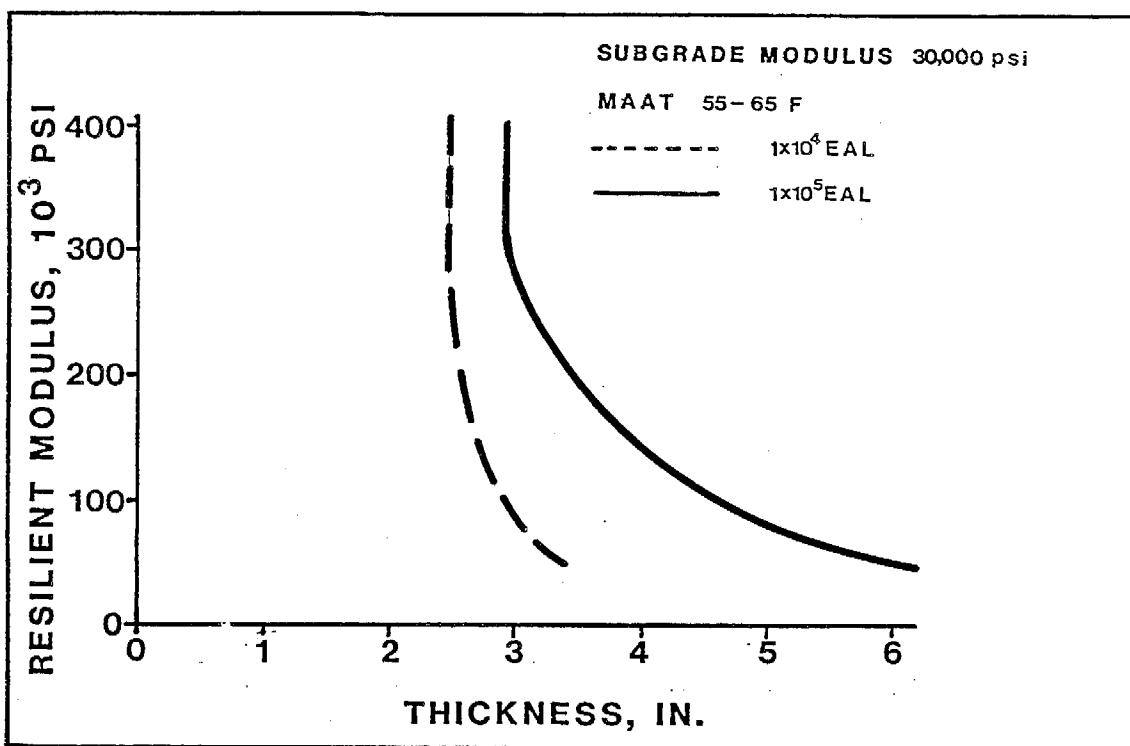


Figure E8. Thickness For Subgrade Strain Requirement,  
 $E_s = 30,000$  psi, MAAT = 55-65F

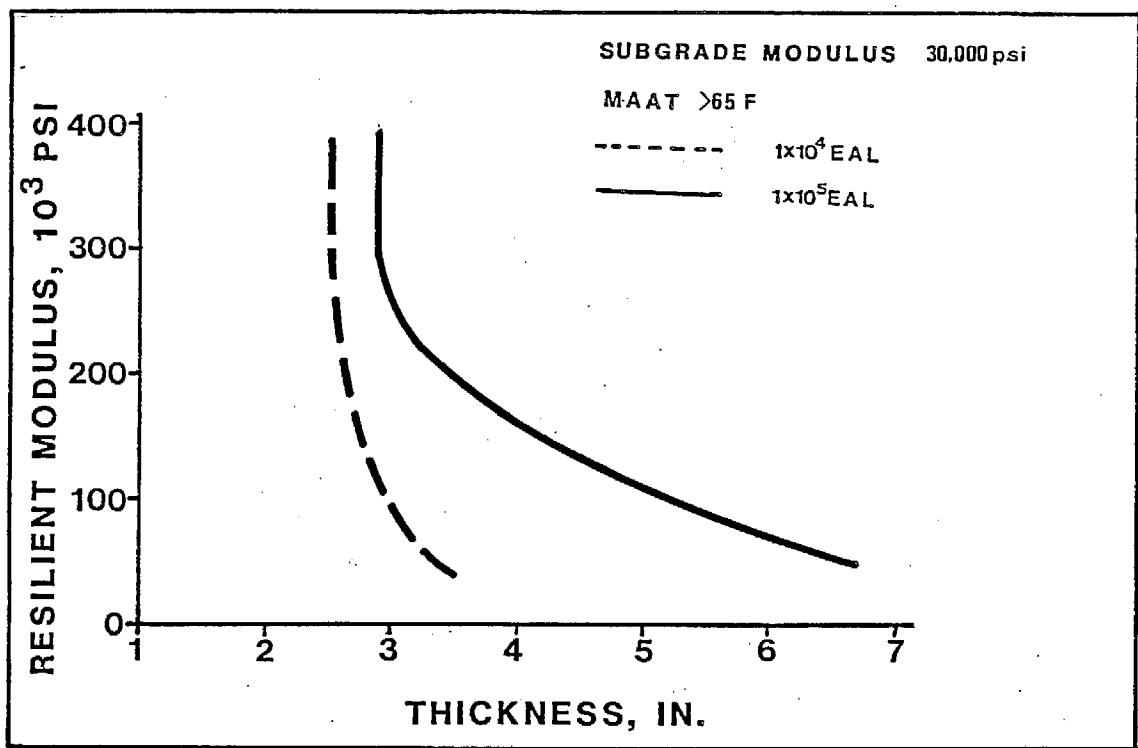


Figure E9. Thickness For Subgrade Strain Requirement,  
 $E_s = 30,000$  psi, MAAT = > 65F

Table E3

Thickness Requirements, inches;  
 $E_s = 6000 \text{ psi}$ ,  $\text{EAL} = 1 \times 10^4$ , MAAT = 55-65F

**EMULSION  
QUALITY LEVEL  
AGGREGATE**

		SAN BERNARDINO		FRESNO		GRANITEROCK	
		HIGH	LOW	HIGH	LOW	HIGH	LOW
C S S O	M <sub>r</sub> T <sub>i</sub> CF T <sub>c</sub> T <sub>s</sub>	246,000 3.4 .64 3.7 4.3	300,000 3.1 .68 4.0 4.3	391,000 2.7 .61 3.3 4.3	362,000 2.8 .64 3.1 4.3	260,000 2.8 .61 3.5 4.3	333,000 3.0 .65 3.3 4.3
C M M S O	M <sub>r</sub> T <sub>i</sub> CF T <sub>c</sub> T <sub>s</sub>	259,000 2.9 .59 3.6 4.3	288,000 3.2 .61 3.8 4.3	271,000 3.2 .59 3.9 4.3	339,000 3.0 .60 3.7 4.3	284,000 3.2 .59 4.0 4.3	365,000 2.9 .60 3.7 4.3
C M M S 7	M <sub>r</sub> T <sub>i</sub> CF T <sub>c</sub> T <sub>s</sub>	71,000 5.5 .65 6.0 4.3	103,000 4.7 .71 4.5 4.3	74,000 5.4 .67 5.3 4.3	123,000 4.4 .69 4.5 4.3	85,000 5.2 .65 5.4 4.3	123,000 4.4 .73 4.6 4.3
SS 15	M <sub>r</sub> T <sub>i</sub> CF T <sub>c</sub> T <sub>s</sub>	298,000 3.1 .57 4.0 4.3	285,000 3.2 .59 3.8 4.3	365,000 2.8 .58 3.7 4.3	334,000 3.0 .61 3.6 4.3	320,000 3.0 .60 3.6 4.3	329,000 3.0 .61 3.6 4.3
SS 30	M <sub>r</sub> T <sub>i</sub> CF T <sub>c</sub> T <sub>s</sub>	296,000 3.1 .60 3.7 4.3	296,000 3.1 .62 3.6 4.3	339,000 3.0 .59 3.8 4.3	335,000 3.0 .63 3.5 4.3	313,000 3.1 .65 3.4 4.3	309,000 3.1 .65 3.4 4.3

Note:

$M_r$  = Resilient modulus in psi

$T_i$  = Uncorrected thickness for tensile strain requirements, inches

CF = Correction factor for air voids and binder volume

$T_c$  = Corrected thickness for tensile strain requirements, inches

$T_s$  = Thickness for subgrade strain requirements, inches

Table E4

Thickness Requirements, inches;  
 $E_s = 6000 \text{ psi}$ ,  $EAL = 1 \times 10^5$ , MAAT = 55-65F

**EMULSION  
QUALITY LEVEL  
AGGREGATE**

		SAN BERNARDINO		FRESNO		GRANITEROCK	
		HIGH	LOW	HIGH	LOW	HIGH	LOW
CSSO	M <sub>r</sub>	246,000	300,000	391,000	362,000	260,000	333,000
CSSO	T <sub>i</sub>	.6.8	6.2	5.5	5.7	5.7	5.9
CMSO	CF	.64	.68	.61	.64	.61	.65
CMSO	T <sub>c</sub>	7.4	6.2	6.5	6.3	6.8	6.5
CMSO	T <sub>s</sub>	7.0	6.8	6.8	6.8	7.0	6.8
CMS7	M <sub>r</sub>	259,000	288,000	271,000	339,000	284,000	365,000
CMS7	T <sub>i</sub>	6.5	6.3	6.4	5.9	6.3	5.7
CMS7	CF	.59	.61	.59	.60	.59	.60
CMS7	T <sub>c</sub>	8.0	7.5	7.8	7.2	7.8	7.0
CMS7	T <sub>s</sub>	7.0	6.8	7.0	6.8	6.8	6.8
SS15	M <sub>r</sub>	71,000	103,000	74,000	123,000	85,000	123,000
SS15	T <sub>i</sub>	10.0	9.0	10.0	8.5	9.5	8.5
SS15	CF	.65	.71	.67	.69	.65	.73
SS15	T <sub>c</sub>	10.7	8.4	10.2	8.5	10.2	7.8
SS15	T <sub>s</sub>	10.5	8.8	10.4	8.1	9.7	8.1
SS30	M <sub>r</sub>	298,000	285,000	365,000	334,000	320,000	329,000
SS30	T <sub>i</sub>	6.2	6.3	5.7	5.9	6.0	5.9
SS30	CF	.57	.59	.58	.61	.60	.61
SS30	T <sub>c</sub>	7.8	7.6	7.2	7.2	7.3	7.0
SS30	T <sub>s</sub>	6.8	6.8	6.8	6.8	6.8	6.8

Note:

M<sub>r</sub> = Resilient modulus in psi

T<sub>i</sub> = Uncorrected thickness for tensile strain requirements, inches

CF = Correction factor for air voids and binder volume

T<sub>c</sub> = Corrected thickness for tensile strain requirements, inches

T<sub>s</sub> = Thickness for subgrade strain requirements, inches

Table E5

Thickness Requirements, inches;  
 $E_s = 6000 \text{ psi}$ ,  $EAL = 1 \times 10^4$ , MAAT = >65F

**EMULSION**  
**QUALITY LEVEL**  
**AGGREGATE**

	SAN BERNARDINO		FRESNO		GRANITEROCK		
	HIGH	LOW	HIGH	LOW	HIGH	LOW	
C S S O	$M_r$ $T_i$ CF $T_c$ $T_s$	246,000 4.0 .64 4.6 4.5	300,000 3.7 .68 3.7 4.3	391,000 3.3 .61 3.8 4.3	362,000 3.5 .64 3.9 4.3	260,000 3.9 .61 4.5 4.5	333,000 3.5 .65 3.8 4.3
C M S O	$M_r$ $T_i$ CF $T_c$ $T_s$	259,000 3.9 .59 4.8 4.5	288,000 3.8 .61 4.6 4.4	271,000 3.8 .59 4.7 4.4	339,000 3.5 .60 4.3 4.3	284,000 3.8 .59 4.6 4.4	365,000 3.5 .60 4.3 4.3
C M S 7	$M_r$ $T_i$ CF $T_c$ $T_s$	71,000 6.0 .65 6.5 6.8	103,000 5.2 .71 4.8 6.4	74,000 6.0 .67 6.0 6.8	123,000 5.0 .69 5.9 6.2	85,000 5.8 .65 6.3 6.7	123,000 5.0 .73 4.9 6.2
SS 15	$M_r$ $T_i$ CF $T_c$ $T_s$	298,000 3.7 .57 5.0 4.3	285,000 3.8 .59 4.8 4.4	365,000 3.5 .58 4.5 4.3	334,000 3.5 .61 4.3 4.3	320,000 3.6 .60 4.4 4.3	329,000 3.7 .61 4.5 4.3
SS 30	$M_r$ $T_i$ CF $T_c$ $T_s$	296,000 3.7 .60 4.5 4.3	296,000 3.7 .62 4.3 4.3	339,000 3.5 .59 4.4 4.3	335,000 3.5 .63 4.1 4.3	313,000 3.6 .65 3.9 4.3	309,000 3.6 .65 3.9 4.3

Note:

$M_r$  = Resilient modulus in psi

$T_i$  = Uncorrected thickness for tensile strain requirements, inches

CF = Correction factor for air voids and binder volume

$T_c$  = Corrected thickness for tensile strain requirements, inches

$T_s$  = Thickness for subgrade strain requirements, inches

Table E6

Thickness Requirements, inches;  
 $E_s = 6000$  psi,  $EAL = 1 \times 10^5$  psi, MAAT = >65F

**EMULSION**  
**QUALITY LEVEL**  
**AGGREGATE**

		SAN BERNARDINO		FRESNO		GRANITEROCK	
		HIGH	LOW	HIGH	LOW	HIGH	LOW
C	$M_r$	246,000	300,000	391,000	362,000	260,000	333,000
S	$T_i$	7.9	7.4	6.9	7.0	7.7	7.1
S	CF	.64	.68	.61	.64	.61	.65
O	$T_c$	8.7	7.4	8.1	7.7	9.0	7.7
	$T_s$	7.0	7.0	7.0	7.0	7.0	7.0
C	$M_r$	259,000	288,000	271,000	339,000	284,000	365,000
M	$T_i$	7.7	7.5	7.6	7.1	7.5	6.9
S	CF	.59	.61	.59	.60	.59	.60
O	$T_c$	9.4	9.0	9.2	8.7	9.1	8.5
	$T_s$	7.0	7.0	7.0	7.0	7.0	7.0
C	$M_r$	71,000	103,000	74,000	123,000	85,000	123,000
M	$T_i$	11.1	10.3	11.1	9.8	10.9	9.8
S	CF	.65	.71	.67	.69	.65	.73
7	$T_c$	11.8	9.5	11.0	9.5	11.9	8.7
	$T_s$	11.2	9.8	11.1	9.3	10.9	9.3
SS	$M_r$	298,000	285,000	365,000	334,000	320,000	329,000
15	$T_i$	7.4	7.5	6.9	7.1	7.2	7.1
	CF	.57	.59	.58	.61	.60	.61
	$T_c$	9.4	9.4	8.8	8.4	8.7	8.4
	$T_s$	7.0	7.0	7.0	7.0	7.0	7.0
SS	$M_r$	296,000	296,000	339,000	335,000	313,000	309,000
30	$T_i$	7.4	7.4	7.1	7.1	7.3	7.3
	CF	.60	.62	.59	.63	.65	.65
	$T_c$	9.0	8.6	8.7	8.2	7.8	7.8
	$T_s$	7.0	7.0	7.0	7.0	7.0	7.0

Note:

$M_r$  = Resilient modulus in psi

$T_i$  = Uncorrected thickness for tensile strain requirements, inches

CF = Correction factor for air voids and binder volume

$T_c$  = Corrected thickness for tensile strain requirements, inches

$T_s$  = Thickness for subgrade strain requirements, inches

Table E7

Thickness Requirements, inches;  
 $E_s = 30,000 \text{ psi}$ ,  $EAL = 1 \times 10^4$ , MAAT = 55-65F

**EMULSION**  
**QUALITY LEVEL**  
**AGGREGATE**

		SAN BERNARDINO		FRESNO		GRANITEROCK	
		HIGH	LOW	HIGH	LOW	HIGH	LOW
C S S O	M <sub>r</sub> T <sub>i</sub> CF T <sub>c</sub> T <sub>s</sub>	246,000 .2.0 .64 2.3 2.5	300,000 2.0 .68 2.0 2.5	391,000 2.0 .61 2.4 2.5	362,000 2.0 .64 2.3 2.5	260,000 2.0 .61 2.4 2.5	333,000 2.0 .65 2.2 2.5
C M M S O	M <sub>r</sub> T <sub>i</sub> CF T <sub>c</sub> T <sub>s</sub>	259,000 2.0 .59 2.5 2.5	288,000 2.0 .61 2.4 2.5	271,000 2.0 .59 2.5 2.5	339,000 2.0 .60 2.5 2.5	284,000 2.0 .59 2.5 2.5	365,000 2.0 .60 2.5 2.5
C M M S 7	M <sub>r</sub> T <sub>i</sub> CF T <sub>c</sub> T <sub>s</sub>	71,000 2.0 .65 2.2 3.1	103,000 2.0 .71 2.0 2.9	74,000 2.0 .67 2.1 3.1	123,000 2.0 .69 2.0 2.8	85,000 2.0 .65 2.2 3.0	123,000 2.0 .73 2.0 2.8
SS 15	M <sub>r</sub> T <sub>i</sub> CF T <sub>c</sub> T <sub>s</sub>	298,000 2.0 .57 2.6 2.5	285,000 2.0 .59 2.5 2.5	365,000 2.0 .58 2.6 2.5	334,000 2.0 .61 2.4 2.5	320,000 2.0 .60 2.5 2.5	329,000 2.0 .61 2.4 2.5
SS 30	M <sub>r</sub> T <sub>i</sub> CF T <sub>c</sub> T <sub>s</sub>	296,000 2.0 .60 2.5 2.5	296,000 2.0 .62 2.4 2.5	339,000 2.0 .59 2.5 2.5	335,000 2.0 .63 2.3 2.5	313,000 2.0 .65 2.2 2.5	309,000 2.0 .65 2.2 2.5

Note:

$M_r$  = Resilient modulus in psi

$T_i$  = Uncorrected thickness for tensile strain requirements, inches

CF = Correction factor for air voids and binder volume

$T_c$  = Corrected thickness for tensile strain requirements, inches

$T_s$  = Thickness for subgrade strain requirements, inches

Table E8

Thickness Requirements, inches;  
 $E_s = 30,000 \text{ psi}$ ,  $\text{EAL} = 1 \times 10^5$ ,  $\text{MAAT} = 55-65\text{F}$

**EMULSION**  
**QUALITY LEVEL**  
**AGGREGATE**

	SAN BERNARDINO		FRESNO		GRANITEROCK		
	HIGH	LOW	HIGH	LOW	HIGH	LOW	
CSSO	M <sub>r</sub> T <sub>i</sub> CF T <sub>c</sub> T <sub>s</sub>	246,000 2.2 .64 2.4 3.2	300,000 2.0 .68 2.0 2.9	391,000 2.0 .61 2.4 2.9	362,000 .64 2.3 2.9	260,000 2.1 .61 2.4 3.1	333,000 2.0 .65 2.3 2.9
CMSO	M <sub>r</sub> T <sub>i</sub> CF T <sub>c</sub> T <sub>s</sub>	259,000 2.1 .59 2.5 3.1	288,000 2.1 .61 2.4 3.0	271,000 2.1 .59 2.5 3.0	339,000 2.0 .60 2.5 2.9	284,000 2.1 .59 2.5 3.0	365,000 2.0 .60 2.5 2.9
CMS7	M <sub>r</sub> T <sub>i</sub> CF T <sub>c</sub> T <sub>s</sub>	71,000 2.7 .65 2.8 5.3	103,000 2.5 .71 2.4 4.5	74,000 2.7 .67 2.8 5.3	123,000 2.4 .69 2.3 4.3	85,000 2.6 .65 2.7 4.9	123,000 2.4 .73 2.2 4.3
SS15	M <sub>r</sub> T <sub>i</sub> CF T <sub>c</sub> T <sub>s</sub>	298,000 2.0 .57 2.7 2.9	285,000 2.1 .59 2.6 3.0	365,000 2.0 .58 2.7 2.9	334,000 2.0 .61 2.4 2.9	320,000 2.0 .60 2.5 2.9	329,000 2.0 .61 2.4 2.9
SS30	M <sub>r</sub> T <sub>i</sub> CF T <sub>c</sub> T <sub>s</sub>	296,000 2.0 .60 2.4 2.9	296,000 2.0 .62 2.3 2.9	339,000 2.0 .59 2.4 2.9	335,000 2.0 .63 2.3 2.9	313,000 2.0 .65 2.3 2.9	309,000 2.0 .65 2.3 2.9

Note:

M = Resilient modulus in psi

T<sub>i</sub> = Uncorrected thickness for tensile strain requirements, inches

CF = Correction factor for air voids and binder volume

T<sub>c</sub> = Corrected thickness for tensile strain requirements, inchesT<sub>s</sub> = Thickness for subgrade strain requirements, inches

Table E9

Thickness Requirements, inches;  
 $E_s = 30,000 \text{ psi}$ ,  $\text{EAL} = 1 \times 10^4$ ,  $\text{MAAT} = >65\text{F}$

**EMULSION  
QUALITY LEVEL  
AGGREGATE**

		SAN BERNARDINO		FRESNO		GRANITEROCK	
		HIGH	LOW	HIGH	LOW	HIGH	LOW
C	M <sub>r</sub>	246,000	300,000	391,000	362,000	260,000	333,000
S	T <sub>i</sub>	2.0	2.0	2.0	2.0	2.0	2.0
S	CF	.64	.68	.61	.64	.61	.65
O	T <sub>c</sub>	2.3	2.1	2.4	2.3	2.4	2.2
O	T <sub>s</sub>	2.5	2.5	2.5	2.5	2.5	2.5
C	M <sub>r</sub>	259,000	288,000	271,000	339,000	284,000	365,000
M	T <sub>i</sub>	2.0	2.0	2.0	2.0	2.0	2.0
S	CF	.59	.61	.59	.60	.59	.60
O	T <sub>c</sub>	2.6	2.4	2.6	2.5	2.6	2.5
O	T <sub>s</sub>	2.5	2.5	2.5	2.5	2.5	2.5
C	M <sub>r</sub>	71,000	103,000	74,000	123,000	85,000	123,000
M	T <sub>i</sub>	2.0	2.0	2.0	2.0	2.0	2.0
S	CF	.65	.71	.67	.69	.65	.73
7	T <sub>c</sub>	2.2	2.0	2.1	2.0	2.2	2.0
7	T <sub>s</sub>	5.8	5.2	5.8	4.8	5.7	4.8
SS	M <sub>r</sub>	298,000	285,000	365,000	334,000	320,000	329,000
15	T <sub>i</sub>	2.0	2.0	2.0	2.0	2.0	2.0
15	CF	.57	.59	.58	.61	.60	.61
15	T <sub>c</sub>	2.7	2.6	2.6	2.4	2.5	2.4
15	T <sub>s</sub>	2.5	2.5	2.5	2.5	2.5	2.5
SS	M <sub>r</sub>	296,000	296,000	339,000	335,000	313,000	309,000
30	T <sub>i</sub>	2.0	2.0	2.0	2.0	2.0	2.0
30	CF	.60	.62	.59	.63	.65	.65
30	T <sub>c</sub>	2.5	2.4	2.6	2.3	2.2	2.2
30	T <sub>s</sub>	2.5	2.5	2.5	2.5	2.5	2.5

Note:

 $M_r$  = Resilient modulus in psi $T_i$  = Uncorrected thickness for tensile strain requirements, inches

CF = Correction factor for air voids and binder volume

 $T_c$  = Corrected thickness for tensile strain requirements, inches $T_s$  = Thickness for subgrade strain requirements, inches

Table E10

Thickness Requirements, inches;  
 $E_s = 30,000 \text{ psi}$ ,  $\text{EAL} = 1 \times 10^5$ ,  $\text{MAAT} = > 65\text{F}$

**EMULSION  
QUALITY LEVEL  
AGGREGATE**

	<b>SAN BERNARDINO</b>	<b>FRESNO</b>		<b>GRANITEROCK</b>		
		<b>HIGH</b>	<b>LOW</b>	<b>HIGH</b>	<b>LOW</b>	
CSSO	M <sub>r</sub> 246,000 T <sub>i</sub> 2.4 CF .64 T <sub>c</sub> 2.7 T <sub>s</sub> 3.1	300,000 2.3 .68 2.4 2.9	391,000 2.2 .61 2.5 2.9	362,000 2.2 .64 2.5 2.9	260,000 2.6 .61 3.1 3.0	333,000 2.2 .65 2.4 2.9
CMSO	M <sub>r</sub> 259,000 T <sub>i</sub> 2.3 CF .59 T <sub>c</sub> 2.8 T <sub>s</sub> 3.0	288,000 2.3 .61 2.7 3.0	271,000 2.3 .59 2.8 3.0	339,000 2.2 .60 2.6 2.9	284,000 2.3 .59 2.8 3.0	365,000 2.1 .60 2.5 2.9
CMS7	M <sub>r</sub> 71,000 T <sub>i</sub> 2.8 CF .65 T <sub>c</sub> 3.0 T <sub>s</sub> 6.1	103,000 2.7 .71 2.7 5.2	74,000 2.8 .67 2.8 6.0	123,000 2.6 .69 2.6 4.8	85,000 2.8 .65 3.1 5.8	123,000 2.6 .73 2.4 4.8
SS15	M <sub>r</sub> 298,000 T <sub>i</sub> 2.3 CF .57 T <sub>c</sub> 2.5 T <sub>s</sub> 2.9	285,000 2.3 .59 2.8 3.0	365,000 2.2 .58 2.8 2.9	334,000 2.2 .61 2.5 2.9	320,000 2.2 .60 2.6 2.9	329,000 2.2 .61 2.5 2.9
SS30	M <sub>r</sub> 296,000 T <sub>i</sub> 2.3 CF .60 T <sub>c</sub> 2.7 T <sub>s</sub> 2.9	296,000 2.3 .62 2.7 2.9	339,000 2.2 .59 2.7 2.9	335,000 2.2 .63 2.5 2.9	313,000 2.2 .65 2.4 2.9	309,000 2.3 .65 2.5 2.9

**Note:**M<sub>r</sub> = Resilient modulus in psiT<sub>i</sub> = Uncorrected thickness for tensile strain requirements, inches

CF = Correction factor for air voids and binder volume

T<sub>c</sub> = Corrected thickness for tensile strain requirements, inchesT<sub>s</sub> = Thickness for subgrade strain requirements, inches